# RESEARCH ON VETIVER GRASS FOR SOIL AND WATER CONSERVATION IN THE UPPER NORTH OF THAILAND

**Phithag Inthapan and Sawatdee Boonchee**
Office of Land Development Region 6,
Land Development Department
Chiang Mai, Thailand

## Abstract

Soil degradation leads to low soil fertility and yield reduction. Vetiver hedgerows across a slope can reduce soil erosion. Research on vetiver ecotypes, cultivation and management has been conducted in Northern Thailand since 1990. The results were distributed to the extension officers and transferred to the farmers facing erosion problems in that region. 'Kamphaeng Phet 1', 'Nakhon Sawan' and 'Sri Lanka' are the recommended vetiver ecotypes in the upper north, whereas 'Mae La Noi', 'Japanese' and 'Indian' are recommended in the highlands. Seedling preparation by using effective tillers submerged in humic acid or water for three days and then transplanted in the field in mid May till the end of June is recommended. On 20/30-percent slopes, 2-3 shoots per hill with 10-cm spacing and 2 to 3-m vertical interval are the optimum planting recommendations.

These techniques are suitable to agricultural conditions because vetiver hedgerows are simple to establish, cost little and are effective to control erosion. They can contribute substantially not only to soil and water conservation in the upper north but also to a better natural resource management for a green environment in the country.

## Introduction

Northern Thailand covers about one third of the country (17 million ha) and is comprised for 52% of highlands, for 33% of uplands and for 15% of lowlands. Particularly, the upper northern part (8.58 million ha) has 72% of highlands, 16.7% of uplands and 11.3% of lowlands and water areas. Due to an increase in hill-tribe population pressure and land pressure in lowland agriculture, forest encroachment has increased markedly in the highlands where slash-and-burn shifting cultivation is practised. Soils are degraded because erosion increases rapidly as a consequence of the traditional cropping system, which knows neither soil and water conservation nor proper crop management. As soil fertility and crop yields decrease, farmers' lives are impeded and ecological balance is under threat. Particularly soil, water and forest are destroyed rapidly.

His Majesty the King has long realized the problems of soil degradation on sloping lands due to soil erosion and runoff. He has recognized the value of vetiver grass as a simple, cheap and efficient technology to fight against erosion. At his suggestion, the Land Development Department has undertaken vetiver experiments in the upper north of Thailand since 1990. Research has concentrated on finding the best-performing varieties and the best management methods.

## Study of Vetiver Ecotypes

At the early stage, there was not much data on vetiver grass species. Theerathorn et al. (1989) initially studied the upland vetiver ecotypes – 'Nakhon Sawan' was planted on contours along slopes and found to be performing well. Then, the Thai-German Highlands Development Project introduced a vetiver grass species from Sri Lanka called 'Sri Lanka' and planted it at the experimental site of the Chiang Mai Land Development Station, located at an elevation of 300 m on an upland with 7-percent slope and 1 200 mm of annual rainfall. The results showed good tillering in 99 clumps that were introduced to be planted and multiplied in the area of the Chiang Mai and Mae Hong Son Land

Development Stations. 'Sri Lanka' vetiver was also introduced to be planted and compared with Napier, Rusi and Bahia grasses on the sloping lands at the Ban Chabo experimental plot of Pang Ma Pa, Mae Hong Son province, located at an elevation of 900 m on a slope complex with 1 300 mm of annual rainfall. The result showed that 'Sri Lanka' performed well in terms of growth and development.

In a comparative study of vetiver ecotypes, Chinapan et al. (1992) studied 27 local vetiver ecotypes in Thailand and the imported ecotype from Sri Lanka on sandy soil, clayey loam soil and skeleton soil in Chiang Mai, Mae Hong Son and Phetchabun provinces, respectively. The results showed that ten vetiver ecotypes could be introduced and planted in Northern Thailand because they possess good characteristics for soil and water conservation, such as good growth and establishment, high tillering ability, strong clumps and non-seed distribution (Appendix 1).

However, the vetiver ecotypes 'Nakhon Sawan', 'Kamphaeng Phet 1' (Faek Don) and 'Sri Lanka' (Faek Lum) are recommended to be planted in Northern Thailand because they perform good establishment at 90 days after transplanting and produce 10-26 tillers/hill, with 11-13 cm of hill size and 89-108 cm of plant height (Table 1), which are good characteristics for soil and water conservation.

Table 1. Tiller number (tiller/hill), hill size (cm) and plant height (cm) of three recommended vetiver species at 90 days after transplanting

| Ecotype | Growth characteristics | | |
|---|---|---|---|
| | Tiller/hill | Diameter (cm) | Height (cm) |
| 1. Nakhon Sawan | 35 | 12 | 89 |
| 2. Kamphaeng Phet 1 | 34 | 12 | 106 |
| 3. Sri Lanka | 10 | 11 | 101 |

** Mean value from 12 sites, soil texture varied from sandy soil, clay loam and skeleton soil*
*Source: Chinapan et al. (1992)*

On the highlands, Inthapan et al. (1998b) compared eight vetiver ecotypes at Pang Tong's Agricultural Center, Central district, Mae Hong Son province, at an elevation of 1 000 - 1 200 m with 20-% slope and low temperatures ranging from 4 to 10°C. They found that 'Kamphaeng Phet 1', 'Japanese', 'Surat Thani' and 'Indian' developed good growth performance at 18 months after transplanting and produced 11-19 tillers/hill, with 7-10 cm of hill size (Figs. 1 and 2).

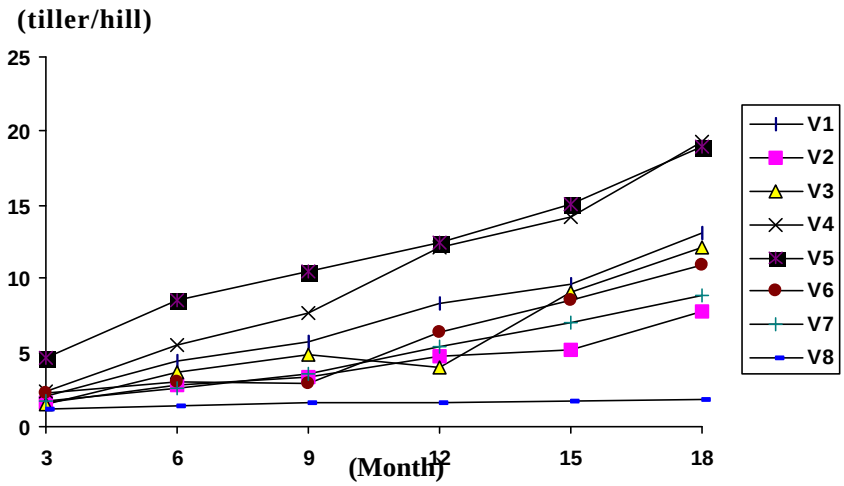
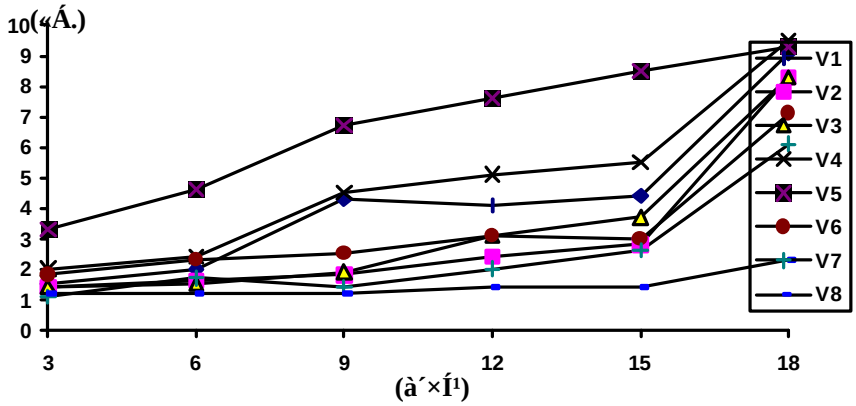



Fig. 1. Tiller/hill of eight different vetiver grasses in the highlands




*NB: V1 = Surat Thani* *V5 = Japanese*
*V2 = Kamphaeng Phet 2* *V6 = Indian*
*V3 = Nakhon Sawan* *V7 = Mae La Noi*
*V4 = Kamphaeng Phet 1* *V8 = Sri Lanka*
*Source: Inthapan et al. (1995)*

Fig. 2. Hill size (cm) of eight different vetiver grass species in the highlands

## The Optimum Planting Date Study

On the uplands and highlands in the upper north of Thailand, rain falls mainly from May to October (1 400-1 700 mm annually) and the planting date of vetiver grass is closely related to the raining period. Inthapan et al. (1995) studied 20 planting dates, weekly concessive from April to the end of December. 'Sri Lanka' was planted on the Hang Chat soil series (Soil Unit Group No.29) with 7-% slope in the upper north of Thailand. The study showed that the appropriate planting date should be between mid May and mid August, because the soil moisture content, as a consequence of the good rainfall distribution, gives vetiver grass an almost 100-% survival chance.

In addition, vetiver grass planted during 15 May to 30 June 1993 produced a larger number of tillers (14.2-17.6 tillers/hill) with hill size of 9.5-10.6 cm, particularly at four months after planting (Fig. 3). Vetiver has a high tillering ability and develops dense hedgerows for soil and water conservation at the end of the rainy season.

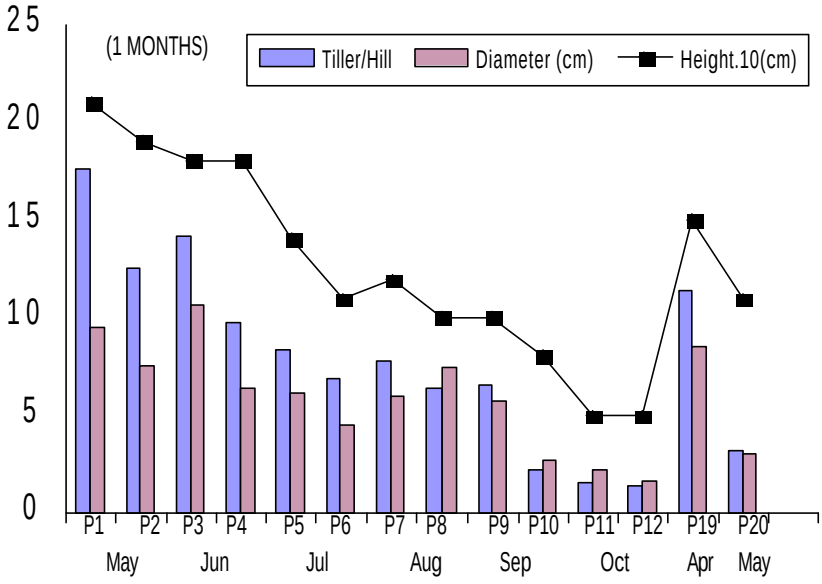


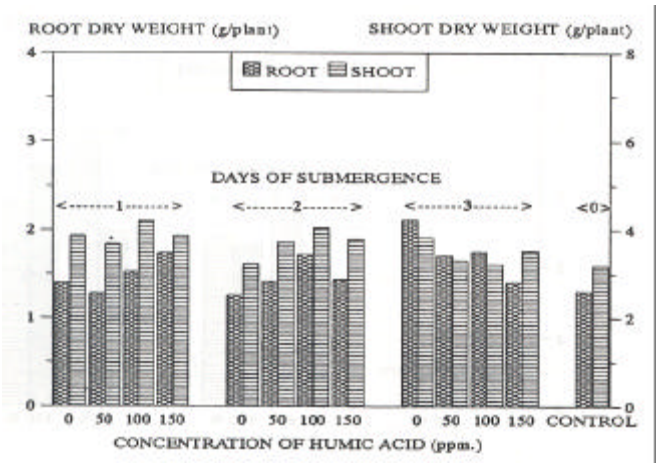

Fig. 3. Tillering ability (tiller/hill), hill size (cm) and plant height (cm) of 'Sri Lanka' at four months after transplanting

## Seedling Preparation and Transplanting

Jirasathaworn and Sutharuk (1995) studied vetiver grass submerged in humic acid at different concentrations for one, two and three days, compared with submerged in freshwater, before transplanting to black plastic bags, at the Huai Hong Khrai Royal Development Study Center, Doi Saket, Chiang Mai, and found a slightly different root and shoot dry weight of vetiver grass submerged in humic acid at different concentrations: 0, 50, 100, and 150 ppm (Fig. 4) as well as differences in submerging period: vetiver submerged in humic acid for three days produced more root and shoot dry weight than vetiver treated similarly for one or two days. In addition, the three-day treatment produced a larger number of new roots and was growing faster after transplanting seedlings in black plastic bags. Therefore vetiver bare roots should be submerged in solution for three days till they produce new roots and then transplanted to the field area; this method of seedling preparation is more convenient and less time- and labour-consuming than using seedling plastic bags.

## Number of Rows in a Vetiver Hedgerow

The number of rows in a vetiver hedge is related to the number of seedlings; the more rows, the more seedlings; reducing the number of rows of a vetiver hedge can save a number of seedlings. Inthapan et al. (1998a) conducted the study on row numbers of the vetiver ecotype 'Sri Lanka' at the Tha Yang soil series (Soil Unit Group 48), characterized by sandy loam soil, shallow soil with gravel in the subsoil with low soil fertility and erosion-prone surface, on a 20-% slope at an elevation of 600 m with 1 374 mm of annual rainfall. The result indicated that single and double rows with 30-cm row spacing and 10-cm hill spacing provided non-significant differences in soil and water conservation compared to farmers' practice of no vetiver hedge. Single row planting of vetiver hedges produced 0.95 t/ha of soil loss, whereas two-row hedgerows gave only 0.71 t/ha of soil loss or about 12.4 % of farmers' practice of no vetiver hedge (Table 2).




*Source: Jirasathaworn and Sutharuk (1995)*

Fig. 4. Root and shoot dry weight of vetiver grass submerged in humic acid at different concentrations for three days

Table 2. Effect of the number of rows of a vetiver hedge on soil loss [t/ha], Chiang Mai

| Treatment | Soil loss [t/ha] |
|---|---|
| 1. Farmers' practice | 5.70 a* |
| 2. Single-row planting | 0.95 b |
| 3. Double-row planting | 0.71 b |

** Figures followed by letters indicate significant difference at 95 %*
*Source: Inthapan et al. (1998a)*

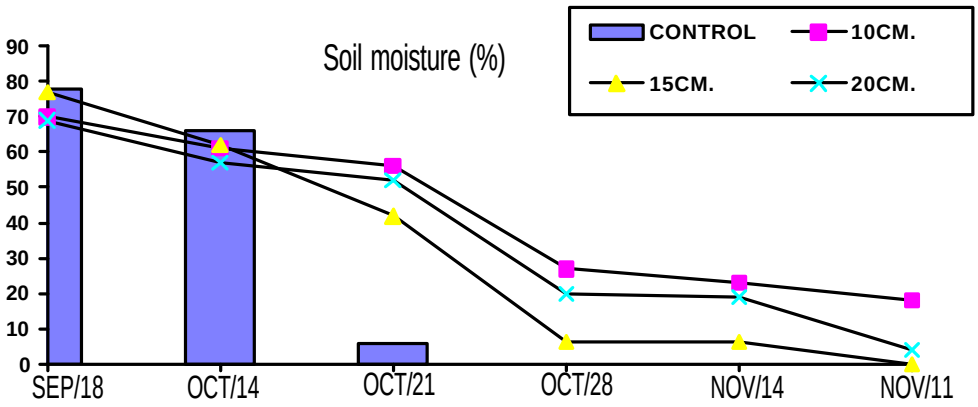
### Study of Plant Spacing and Hill Spacing

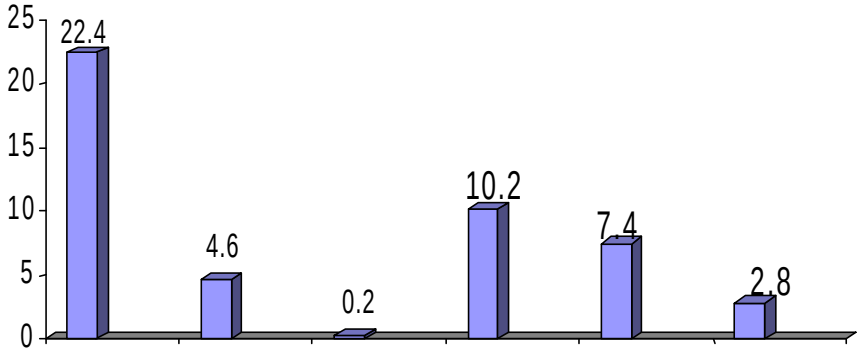
Study of plant spacing and hill spacing can indicate how plant and hill spacing influence soil and water conservation. Inthapan et al. (1998a) studied the different plant and hill spacing of 'Sri Lanka' on the Tha Yang soil series (Soil Unit Group 48), characterized by sandy loam soil, shallow soil with gravel in subsoil, low soil fertility and erosion problem, on a 20-% slope at an elevation of 600 m with 1 374 mm of rain per year. The result indicated that 10, 15 and 20-cm hill spacing were good and not significantly different for soil and water conservation, whereas they differed from farmers' practice with no vetiver hedge. Soil loss of trial with vetiver hedgerow was only 14.6 % of trial with farmers' practice (Table 3). However, vetiver hedges with close hill spacing (10 cm) enhanced tiller growth, developed rapidly into dense rows and were effective for soil and water conservation.

Table 3. Effects of hill spacing of vetiver hedge on soil loss (t/ha) (Chiang Mai province)

| Treatment | Soil loss [t/ha] |
|---|---|
| 1. Farmers' practice | 5.70 a* |
| 2. Hill spacing 10 cm | 0.87 b |
| 3. Hill spacing 15 cm | 0.82 b |
| 4. Hill spacing 20 cm | 0.80 b |

** Figures followed by letters indicate significant difference at 95 %*
*Source: Inthapan et al. (1998a)*




*Source : Inthapan et al. (1998a)*

Fig. 5. Effect of hill spacing on soil moisture content (Chiang Mai province)

Soil moisture measured at 50 cm above vetiver hedgerow showed that soil moisture content of an experimental plot with vetiver hedgerow was higher than that of a plot without vetiver hedgerow and a close hill spacing treatment conserved more moisture in the soil better than that with wider hill spacing, particularly at the end of the rainy season in October or November. This indicated that vetiver hedgerows conserve soil moisture better (Fig. 5).

**Study on Vertical Interval of Vetiver Hedgerows**

The effect of vetiver hedgerows at different vertical intervals for soil and water conservation was studied by Inthapan et al. (1995). 'Sri Lanka' hedgerows were planted at vertical intervals of 1.0, 2.0, and 3.0 on the Tha Yang soil series (Soil Unit Group 48), characterized by sandy loam soil, shallow soil with gravel in subsoil, with low soil fertility and an erosion problem, on 20-% slopes at 600 m elevation with 1 374 mm of rain annually in Chiang Dao, Chiang Mai province. The results in 1993-95 showed that the different intervals were more or less the same and not significantly different in soil erosion measured. An average soil loss was 3.27 t/ha and only 59 and 31 % of those of farmers' practice and without vetiver hedgerow treatments respectively (Table 4).

Table 4. Effect of vetiver hedgerow at different vertical intervals on soil erosion in 1993-95 (Chiang Mai province)

| Treatment | Soil loss [t/ha] |
|---|---|
| 1. Bare soil | 26.05 a* |
| 2. Farmers' practice [corn/black bean] | 5.49 b |
| 3. Counter planting [corn/black bean] | 3.76 b |
| 4. Counter planting + vetiver [VI = 1 m] | 3.08 b |
| 5. Counter planting + vetiver [VI = 2 m] | 3.32 b |
| 6. Counter planting + vetiver [VI = 3 m] | 3.41 b |

*VI = vertical interval*
** Figures followed by letters indicate significant difference at 95 %*
*Source: Inthapan et al. (1996)*

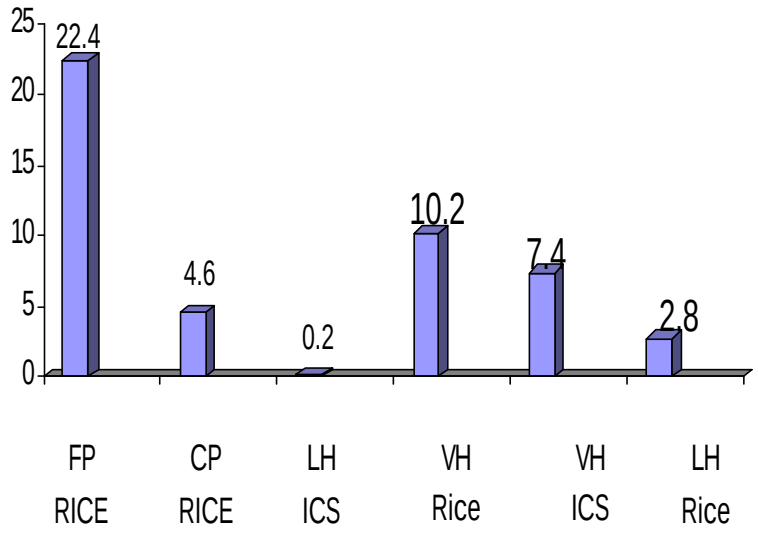



Fig. 6. Amount of soil loss (t/ha) from different treatments at Mae Hong Son province in 1992
Source: Peukrai et al. (1994)
NB: FP = Farmers' practice LH = Leguminous hedgerow CP = Contour planting
VH = Vetiver hedgerow ICS = Integrated cropping system

### Study of a Comparison of Vetiver Hedgerows with Other Grass or Leguminous Hedgerows

Peukrai et al. (1994) compared 'Sri Lanka' hedges with leguminous hedgerows (*Leucaena* and pigeon pea) in Pang Ma Pa, Mae Hong Son province, on a slope complex at 900 m elevation with 20-40-% slope and 1 261 mm of rain per year. The vertical interval of vetiver hedgerows and leguminous hedgerows was 3.0 m. In 1992-93, a comparison of upland rice and integrated cropping system planting hedgerows showed that they were both good for soil and water conservation in which the soil of both strips was only 29 and17 % of farmers' practice (Fig. 6).

According to that study, it was found that vetiver hedgerows and leguminous hedgerows with integrated cropping system along hedgerows reduced soil loss on average by about 3.8 t/ha or only 18% of that of farmers' practice with mono-cropping of upland rice.

In addition, Kanchanadul et al. (1995) studied 'Sri Lanka' hedges compared with natural grass strips and the conservation cropping system at Huai Chakan village near Chiang Dao, Chiang Mai province, on the Wang Hi soil series with 25-% slope at 600 m elevation. The study indicated that all treatments were not significantly different for soil and water conservation, whereas they differed from farmers' practice with mono-cropping upland rice. Table 5 shows that the amount of soil loss and water runoff from those treatments were about 52 and 82% of farmers' practice with upland rice, as the hedgerows (vetiver and leguminous shrub) and natural grass strips can reduce soil and water runoff, which enhances water infiltration, providing soil moisture available for crop growth, in particular during the dry period.

Table 5. Effect of conservation cropping system on soil loss (t/ha) and runoff ($m^3$/ha) at the Chiang Mai site during 1993-95

| Treatment | Runoff [$m^3$/ha] | Soil loss [t/ha] |
|---|---|---|
| 1. Upland rice | 5 800 | 2.41 a* |
| 2. Upland rice / peanut / vetiver hedge | 4 819 | 1.27 b |
| 3. Upland rice / peanut / natural grass strip | 4 738 | 1.21 b |
| 4. Upland rice / peanut / NFT hedge | 4 781 | 1.28 b |

*NFT = Leucaena + Pigeon pea*
** Figures followed by letters indicate significant difference at 95 % (MRT)*
*Source: Kanchanadul et al. (1998)*

## Summary and Discussion

Since 1995, research on vetiver hedgerows for soil and water conservation in the upper north of Thailand has shown that planted along contour lines of 20/40-% slopes at elevations of 500/1 200 m with 1 200/1 300 mm annual rainfall, they can prevent soil erosion as well as slow down water runoff, thus enhancing soil moisture. The recommended vetiver ecotypes in that area are 'Kamphaeng Phet 1', 'Nakhon Sawan' and 'Sri Lanka'. On the highlands, where temperatures are low, 'Mae La Noi', 'Japanese' and 'Indian' are recommended.

Bare root planting can be done by using healthy and effective tillers submerged in humic acid or water for three days producing new roots and then transplanting them to the field between mid May and the end of June. They should be planted with 10-cm hill spacing on 20/30-percent slopes. The 2-3 m vertical interval of vetiver hedgerows is most suitable, losing little space of cultivation. Ten-cm hill spacing enhances the growth and effectiveness of the hedgerow. The use of vetiver is suitable to farmers' agricultural conditions as it requires little practice, does not cost much and is effective for soil conservation. Therefore, vetiver hedgerows practices should be recommended and transferred to the farmers on the sloping lands in the upper north of Thailand for soil erosion protection. Vetiver hedgerows will help preserve the natural resources and the environment of the country.

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## References

Chalothorn, C. 1998. Planting vetiver using the bare root soaking technique. Proc. ICV-1, p. 44.

Chinapan, W.; Sukhasem, A.; and L. Moncharoen. 1992. Comparative study of vetiver grass ecotypes in Thailand. Soil and Water Conservation Division, Soil Survey and Classification Division, Land Development Department, Bangkok (in Thai).

Inthapan, P.; Vatatum, S.; and S. Boonchee. 1995. A study on planting date of vetiver grass on the Hang Chat soil series (Chiang Mai province). Paper presented at the 33rd Field Crop Seminar. 30 January-1 February 1995. Kasetsart University, Bangkok (in Thai).

Inthapan, P.; Anecksamphant, C.; and S. Boonchee. 1998a. Comparison of the effectiveness of different vertical intervals, row numbers and plant spacing of vetiver grass for soil and water conservation. Proc. ICV-1, pp. 220-225.

Inthapan, P., Boonchee, S. and S. Puengton. 1998b. A comparison of vetiver grass species in the highland of Northern Thailand. Technical Section, Office of Land Development Region 6, Chiang Mai, Thailand (in Thai).

Jirasataworn, R.; and P. Sutharuk. 1995. The use of vetiver grass for soil and water conservation in Northern Thailand. Paper presented at the 33rd Field Crop Seminar. 30 January-1 February 1995. Kasetsart University, Bangkok (in Thai).

Kanchanadul, V.; Udpuang, N.; Inthapan, P.; and Boonchee, S. 1998. Comparison of soil and moisture content by using different cropping patterns for soil and water conservation on steep land. Paper presented at the 5th Land Development Department Seminar. 20-30 January 1998. Saraburi, Thailand (in Thai).

Peukrai, S.; Inthapan, P.; and S. Boonchee. 1994. The effect of land and crop management on soil erosion in the highlands of Northern Thailand. Poster presented in the 2nd Land Development Department Research Workshop. 8-11 May 1994. Phetchaburi, Thailand (in Thai).

Suebsiri, B. 1998. The use of vetiver hedges in soil and water conservation systems under the Royal Project Foundation in northern Thailand. Proc. ICV-1, pp. 27-29.

Theerathorn, A.; Supasawatsun, C.; Boonroungyotsriri, S.; and P. Atthawiroj. 1989. Vetiver grass, a new hope for soil and water conservation. Annual Report. Land Development Department, Bangkok, pp. 175-192 (in Thai).