

## **Uses and Utilization of Vetiver**

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### *Abstract*

Vetiver is a true miracle grass by its character of special massive long roots that anchoring and penetrating straight into the ground. In old days, it was commonly used for making thatch, handy crafts, perfumery, and employed in religious activities. Only few decades, were largely used at larger scale for soil and water conservation and agricultural practices. At present, the miracle grass was broadly modified to use for environmental protection and other non-agricultural applications and also as an industrial scale.

Vetiver and its component parts have widely developed for other miscellaneous uses, i.e. as construction materials, forage for livestock, landscaping and ornamentals, mulch, compost, veneer, fiber board, ash for concrete work, and insecticide. The grass also was brought to get rid of heavy metals from industry sewage, leach ate form garbage, and take part in various industrial commercial products.

The achievement of Vetiver is considered only reach the first step, it is expected that in future Vetiver will be more important as a socio-economic tool for many countries and popularly used for making clean environment at the global concern.

# 1. Introduction

The present campaign on the planting of vetiver in agricultural and non-agricultural areas for soil and water conservation has met with some problems, in that the growers are not willing to plant vetiver as there is no direct income derived from such planting. In addition to conventional uses, the vetiver plant can also be used as forage for livestock grazing, as ornamental plant, and some other miscellaneous uses. In normal practice of growing vetiver for soil and water conservation, etc., there is a need to cut down the leaves every few months to encourage tiller growth and to reduce the danger of fire in the dry season. The cut leaves and culms can be utilized in various ways thereby providing extra income for the growers. In addition, the roots can also be utilized as a source of essential oil and botanical pesticides.

This paper presented attempts to distinguish between the terms ‘use’ of *live* vetiver plants and ‘utilization’ of *harvested parts* of vetiver plants. It then describes various other uses of the *live* vetiver plants, and utilization of *harvested* vetiver leaves, culms, and roots.

## 1.1 Definition of Use and Utilization as Applied to Vetiver

**Use:** In this paper, ‘use’ is defined as “any direct exploitation of the *live* vetiver plants”.

**Utilization:** In this paper, ‘utilization’ is defined as “the act of making profitable use of *harvested (fresh, partly dried or dried)* vetiver plant parts”.

## 1.2 Uses of *Live* Vetiver Plants

There are two main approaches of making use of *live* vetiver plants, namely:

**1.2.1 Conventional Uses:** These are the uses of *live* vetiver plant to perform specific functions in agricultural and non-agricultural applications, such as for soil and water conservation, slope stabilization, erosion control, environmental protection, absorption of heavy metals, disaster mitigation, wastewater treatment and water purification, etc. Note that vetiver plants have been put to work when they are alive, and not being harvested and processed into finished or semi-finished products.

**1.2.2 Other Uses:** These are the non-conventional uses of *live* vetiver plants such as forages for livestock grazing, ornamentals, and miscellaneous other uses.

## 1.3 Utilization of *Harvested* Vetiver Plants

As applied to vetiver, this involves the utilization of dried, partly dried, or even freshly harvested leaves and culms, and roots of the vetiver plant, either with no processing at all, or with some degrees of processing. These include the production of: (i) non-processed products, e.g. roof thatch, compost, mulch, mushroom medium, animal fodder, bouquet; (ii) semi-processed products, e.g. handicraft, some industrial products, botanical pesticides, pots, low-cost silo, furniture; and (iii) fully-processed products, e.g. essential oil and its derived products, herbal medicine, pulp and paper, fiber board, pozzalan cement, and industrial products.

## **2. Conventional Uses of Live Vetiver Plants**

Since there are many other documents describing these uses, the present document will only briefly describe them.

### **2.1 Agricultural Applications**

#### **2.1.1 Soil and Water Conservation**

##### **2.1.1.1 Erosion Control**

##### **2.1.1.2 Slope Stabilization**

##### **2.1.1.3 Embankment Stabilization**

#### **2.1.2 Trapping of Agrochemicals and Nutrients**

### **2.2 Non-Agricultural Applications**

#### **2.2.1 Bioengineering**

##### **2.2.1.1 Erosion Control**

##### **2.2.1.2 Slope Stabilization**

##### **2.2.1.3 Embankment Stabilization**

#### **2.2.2 Phytoremediation**

##### **2.2.2.1 Reclamation of Problem Soils**

###### **(i) Reclamation of Saline Soils**

###### **(ii) Reclamation of Sodic Soils**

###### **(iii) Reclamation of Acid Sulfate Soils**

###### **(iv) Reclamation of Other Deteriorated Soils**

##### **2.2.2.2 Rehabilitation of Contaminated Soils and Water**

###### **(i) Rehabilitation of Contaminated Soils**

###### *a. Treatment of Mining Spoils*

###### *b. Treatment of Landfills and Garbage Dumps*

###### *c. Removal of Agrochemicals and Pesticides*

###### *d. Absorption of Heavy Metals*

###### **(ii) Rehabilitation of Contaminated Water**

###### *a. Water Treatment and Purification*

###### *b. Treatment of Eutrophicated Water*

###### *c. Wetland Applications*

###### *d. Removal of Effluents*

#### **2.2.3 Disaster Prevention**

##### **2.2.3.1 Landslide and Mudslide Prevention**

##### **2.2.3.2 Flood Prevention**

##### **2.2.3.3 Forest Fire Prevention**

## **3. Other Uses of Live Vetiver Plants**

In addition to the conventional uses of vetiver plant to perform specific functions in agricultural and non-agricultural applications as described in Chapter 2, *live* vetiver plant have many other uses, as described below:

### 3.1 Forage for Livestock Grazing

Many investigators (e.g. Panichpol *et al.* 1996) have verified that the forage value of freshly cut vetiver leaves is comparable to other grasses. They also found that vetiver leaves contained insignificant amount of toxic substances, thus not harmful to the livestock. Vetiver is probably the only grass that provides any feed value at all during drought period. In Africa, for example, vast plains of *V. nigriflora* are burnt each spring to produce an early bite for Fulani livestock (Juliard, pers. comm.).

### 3.2 Ornamentals

Being a grass with a beautiful form and aesthetic value, vetiver is sometimes used as an ornamental plant in landscaping, or as a decorative potted plant. These are discussed below:

**3.2.1 Landscaping:** Vetiver is a beautiful ornamental plant for gardens, patios, decks, etc. The bush of the vetiver plant is so large that it hides unsightly structures. Grown as a hedge, i.e. planting close together in line, it forms a dense, uniform, and attractive hedge under tropical and subtropical climates. It also forms an aesthetically beautiful barrier to unsightly view. Examples of the various uses of vetiver in landscaping are the followings:

**3.2.1.1 As a Decorative Hedge:** Vetiver is used as a decorative hedge on roundabouts. It looks good and seems to serve a good purpose. For example, it is grown primarily for aesthetic reasons by the C'mara Municipal de Portim'o, Portugal (Pease 2002a). These hedges also serve a useful function by hiding from view the traffic that is passing on the opposite side of the roundabouts.

**3.2.1.2 For Dual Purpose in Beautifying the Landscape and Environmental Protection:** Vetiver hedges have been used to stabilize soils and control erosion in amenity sites such as golf courses and water park recreational areas. In many countries such as Australia, China, South Africa, the use of vetiver hedgerows as a combined landscaping and land stabilization tool also produce an aesthetically pleasing hedgerow system. In Thailand, vetiver hedgerows are used very effectively as borders to vegetable plots and flowerbeds, for filtering runoff water to farm ponds and for stabilizing their banks. Along the winding road up hill leading to the Doi Tung Development Project, Chiang Rai, vetiver was planted for decorative and ornamental purposes, in addition to its main objective of stabilizing roadside. On the US Virgin Islands, construction of hotels and condominiums has added stress to the coral reef. These commercial properties are beautifully landscaped. Vetiver was planted in spring of 1999 along a huge side slope of a highway in Qinggliu County of Fujian Province, China, in conjunction with limited use of concrete walls at the most critical sections. A dense living hedge of vetiver formed after 3-4 months. The total cost for vetiver planting was only 50% of using other types of grasses, but the result is a green cover of the side slope instead of a huge concrete wall, which 'look like a tomb' (Xu, pers. comm.).

**3.2.1.3 For Reservoir Landscaping:** A common problem found around reservoirs is the barren strip on the shore caused by the fluctuation of the water level in the reservoir. The height of this level sometimes exceeds 10 m. Since reservoirs have become recreation sites and efforts to vegetate the banks have been unsuccessful in the past, vetiver, by virtue of its resistance to surviving in the water for a period of time, has been used to be grown on the bare banks of a reservoir in China which, after four months, were greened up

completely (Xu, pers. comm.). In Thailand, vetiver was planted on reservoir bank of Kasetsart University Chalermprakiat Sakon Nakhon Campus (Anon. 2000). The result was beautiful scenery along the reservoir, with no erosion of the lateritic soil.

**3.2.2 Decorative Potted Plant:** Grown in large pots, vetiver forms a nice bush with green foliages, some upright while the others drooping. They can be used to decorate platforms, stages, etc., as seen in the followings: Potted vetiver plants were used to decorate the stage at ICV-2 held at Dusit Resort in Cha-am, Phetchaburi, Thailand during 18-22 January 2000. In Senegal, small growers and nurseries grow vetiver in large clay pots and sell in nearby towns and cities for use as ornamental plants (Juliard 2002b). In Vietnam, vetiver is also grown in pots to be used as decorative potted plant outside an office. Thien Sinh Co., an ornamental plant firm, has a plan to promote the use of vetiver for home decoration during the 'Tet' festival (Truong 2002).

### **3.3 Field/Plot Boundaries**

In many places, vetiver has been used as field boundaries, field subdivisions, separation between different sections of garden plots, etc. For example, in West Africa, as early as 1937, Dalziel (1937) reported that vetiver was used as a border for roads, gardens, and cultivated fields to prevent the extension of Dub grass (*Desmostachys bipinnata*). As it does not produce any seeds, and cannot 'move' to other places since it does not have stolons or runners, the demarcation is permanent and clear cut. Maintenance is minimal, by cutting down the leaves every 3-4 months. Many Thai farmers are now using vetiver to separate their fields and vegetable plots. In Senegal, in areas where land-use is intensive, *Vetiveria nigriflora*, is planted to demarcate between vegetable plots to avoid land dispute among farmers (Goudiaby et al. 2003).

### **3.4 Windbreaks**

In addition to preventing dust and heat from coming into the property, thick hedges of vetiver can also act as windbreaks to slowdown strong wind. This has been applied to a field of jojoba crop in Daping Village, Zhonglou Township, Pingtan County, Fujian Province (Xu 2003). Vetiver hedgerows of 6-8 m intervals were interspersed with the jojoba rows and perpendicular to the direction of the strong wind coming from South China Sea. By the end of the second year, vetiver hedges were over 2 m high and could act as effective windbreaks to arrest shifting sand and protect jojoba field.

### **3.5 Dust and Heat Reduction**

A thick and permanent hedge of vetiver can act as an excellent barrier to prevent dust and heat from coming into the properties.

### **3.6 As a Trap Crop for Insect Pests**

Levy (1994) observed that the vetiver plant grown in close proximity to the sugarcane could inhibit to a very substantial degree the attack upon the sugarcane of certain insects such as the cane borer. It was earlier thought that vetiver produces some kind of botanical pesticides (see later) that expelled insect pests, but latest evidence (see below) indicated that it may be due to the effect of insect trapping.

Work by J. Van den Berg of South Africa, and his colleagues (C. Midega, L.J. Wadhams, and Z.R. Khan) presented at ICV-3 shows conclusively that vetiver acts as a trap crop for stem borer. Vetiver hedgerows significantly reduce the amount of stem borer damage to maize and other cereal crops due to the fact that stem borers lay their eggs preferably on vetiver leaves. Due to the hairs on the underside of vetiver leaves the larvae cannot burrow into the vetiver and, therefore, fall off and die. Vetiver leaves are also hosts to insect predators that over winter on the plant, that then attack other insects on the maize in the spring. Stem borer – *Chilo* spp. – is also a problem for rice and sorghum.

Javier Frances of Nobs Hidrodifusion in San Salvador, planted vetiver next to a sugarcane plantation and observed that the stem borers rather lay their eggs on the vetiver than on the sugarcane plant. The sugarcane plant seems to be healthy with very little attack of the stem borers compared with other sugarcane plants in other fields that do not have vetiver along the side. Frances himself has done a lot of work with small farmers that grow corn and has never had complaints about insects.

Forest resource is one of the most important natural resources of the country and humanity. It has profound effect on the equilibrium of the ecosystem. The deterioration of the ecosystem has resulted in increasing crisis from natural disasters. The rapid decline of natural forests instigated by people's invasion for living, and clearing of the forest for timber and other forest products, has prompted the initiation of a research project by a private firm in Thailand for the development of particle boards on a commercial scale in order to be used as a wood substitute.

The objective of this venture is to make use agricultural waste materials such as the leaves of vetiver grass, lemongrass, aromatic pandanus; together with by-products of rice cultivation, i.e. rice hull and rice straw; as well as wood chips, as raw materials for producing of particle boards. These raw materials are either agricultural wastes or by-products which have to be destroyed by burning or other forms of elimination, which often cause environmental problem. This is true for vetiver leaves, which have to be pruned every few months, as well as rice hull, wood chips, and lemongrass leaves. These boards will be used in place of natural wood as an approach for the conservation of the forest, and thus save the nation's precious environment.

The Golden Vetiver Grass Board Industry Co. Ltd., a pioneer firm in the development of particle boards from vetiver and other plants, is under the management of Ms. Parinda Tarevichitsilp. She has an inspiration to produce vetiver grass board on industrial scale for sale in the markets, both in Thailand and abroad. After a considerably long period of research and investigation to produce such boards, she was finally successful. Thus, she started to produce the vetiver grass boards and other products for use as home appliances. Within a period of a short time, the feed back from her customers who use her boards and other products have been pretty good. The company is so proud that it is the first company in Thailand that produces vetiver grass board for sale in Thailand and for export worldwide.

The Golden Vetiver Board Industry will concentrate on developing its products and invent new products from various by-products for producing the boards in order to reduce the load on natural wood obtained from the forest, thereby conserving our precious forest for our children.

Vetiver grass board consists of cellulose, fiber, and lignin, similar to natural wood. The quality of vetiver grass board is specified under JIS A 5908, Level 18. Its density is

750 - 850 kg/m<sup>3</sup>. Vetiver grass board has high strength, is endure and water resistant, with a mild fragrance of the vetiver, and has beautiful ornament pattern. It does not have chemical odor that would injure the eyes and nose. Its property is similar to natural wood. Vetiver grass board can be used to make furniture, or as interior design material such as wall, floor, or ceiling.

The board is easily used in construction. Simply cut the board with normal saw, or preferably precision saw, then smoothen with sandpaper and coat with lacquer. For decorative use, the board should be smoothened with fine-grain sandpaper, and coated with urethane lacquer once again. The boards can be joined together with screw or latex glue.

As for the raw material procurement, the company buys dry leaves of vetiver at the farm gate price of Baht 1-4/kg, depending on the distance from the factory in Samut Prakan Province. This is considered a fair price for the farmers who could earn an extra income from cutting the vetiver leaves, which they have to trim off every few months to rejuvenate the plants. It is estimated that an average dry-weight yield of 1,000 kg per harvest would be obtained from a linear length of 1 km of the vetiver hedgerows, or 1 kg/m. This would give the farmers an extra income of Baht 1,000 to 4,000/km (*ca.* US\$ 25 to 100) of vetiver hedgerows, or double or triple this amount annually if the plant is harvested twice or thrice a year, which is a suggested method for proper maintenance of the vetiver hedgerows.

For further information and photographs of the products, please look in the website: <<http://www.golden-board.com>>

### **3.7 Wincing a Car Out from a Ditch**

This story was publicized in the Vetiver Network Discussion Board (Juliard 2002) whose details are as follows: “One day in August 2002, Scott Grenfelt of the World Wildlife Fund working in Andringitra, Madagascar, and his teammate got caught in a rainstorm on the Namoly-Ambalavo road. The land cruiser they were in slipped down into a ditch of the road with steep bank where vetiver lines the sides. They could not get it out from the ditch. An artist in the car suggested that the winch be hooked up to the vetiver plants along the side of the road and that it would most likely hold the force because the roots are so long. Nobody accepted the idea, but the artist insisted on his idea by winding several strands of the vetiver plants, hooking on the winch to the tied-together plants, revving up the engine and wincing. The car was pulled out with no sweat!”

## **4. Utilization of Harvested Vetiver Plants**

### **4.1 Agriculture-related Activities**

**4.1.1 Mulch:** In tropical countries with high and intensive rainfall, mulching is one of the most important conservation methods. Similar to other mulching materials, vetiver leaves provides shade to the plot, thereby decreasing the temperature and at the same time conserve moisture of the plot and keep weeds under control. Vetiver leaves are excellent materials for mulching; they are durable and long lasting. Vetiver mulch can be applied to vegetable plots, at the base of fruit trees, and field crop plots.

**4.1.2 Compost:** Vetiver leaves and culms are completely decomposed to become soft, disintegrated, and dark brown to black in color. Vetiver compost contains major nutrients from the decomposition process, i.e. N, P, K, Ca, and Mg with a pH of 7.0. In addition, vetiver compost also provides humic acid that enhances soil fertility.

**4.1.3 Nursery Block and Planting Medium:** The Doi Tung Development Project in Chiang Rai, Thailand has attempted to produce nursery block and planting medium from vetiver leaves and culms. The products are now on sale with increasing popularity.

**4.1.4 Fodder:** The young vetiver leaves can be ground to feed fish and livestock, but mature leaves cannot be used for such purposes because their nutritive value is lower than other grasses, and because of the high roughness and silica content. The analysis also indicated that vetiver has the content of crude protein lower than that of other grasses used for animal feed (Anon. 1990b; and Panichpol *et al.* 1996) In the State of Karnataka, India, vetiver is planted along the field boundaries and cut every two weeks or less for use as fodder. Vetiver was found to have relatively higher structural carbohydrates as compared to native grass and rice straw. On the other hand, it also had optimal levels of crude protein, considered to be enough to maximize intake and digestion of the vetiver forage. It was concluded that vetiver may be used as ruminant feed if it is mixed with other good quality feed and forages (Anon 1990b).

**4.1.5 Mushroom Cultivation:** Vetiver leaves contain chemical compounds such as cellulose, hemicellulose, lignin, and crude protein as well as various minerals in which certain mushrooms can feed on. Many investigators have been successful in cultivating mushrooms using vetiver as the medium for their growth. Oyster, shiitake, and straw mushrooms are among those that can be produced using small pieces of vetiver as a medium.

**4.1.6 Botanical Pesticides:** Traditional utilization of vetiver as botanical pesticides in various countries has been extensively reviewed by the senior author (Chomchalow 2001).

**4.1.6.1 Insecticides:** With the evidence that vetiver has no serious insect pests, it is obvious that the insects have an absolute distaste for vetiver, as were reported in the following cases: A farmer in Louisiana reported that in a plot of crop where vetiver was used as mulch, no insects of any kind, including the whitefly, ever came near. It has also been found that the tops of vetiver, in the same formation of mixture with the residue of the roots, will make an absolute repellent for the insects that may damage strawberries grown in southern U.S. (Grimshaw 2002b). Recently, Maistrello and Henderson (1999) found a group of compounds, such as nootkatone, in vetiver roots, which were able to disrupt termite behavior and physiology as a consequence of direct physical contact, ingestion, or exposure to the vapors. They also found that ingestion of wood treated with vetiver oil or nootkatone causes the progressive death of the protozoa living inside the termite gut, ultimately results in a progressive decline of its colony through starvation, as these termites rely on the protozoa for the digestion of their wooden food.

**4.1.6.2 Fungicides:** In New Zealand, Greenfield (2002) noticed that fungal attacks on the vetiver-mulched plants have virtually disappeared and there seem to be little, if any other pest action around the host plants.

**4.1.6.3 Agaricides:** Korpraditkul (1996) found that 10% vetiver oils of different ecotypes were variably able to control cow ticks at both the larval and adult stages.

Furthermore, extract of dry root was able to control adult stage of ticks better than larval stage.

**4.1.7 Allelopathy:** It has been observed that in the vicinity of the vetiver clumps, there is a few other plants growing. It was hypothesized that certain substances excreted by the vetiver plant may have allelopathic action in that they inhibit the growth of other plants. Techapinyawat (1994) reported that root and stem extracts of vetiver could inhibit the germination of soybean seeds. It was concluded that vetiver extract contains in vetiver oil has allelopathic effect in inhibiting the germination of seeds of any plant growing in its vicinity. It was further suggested that this could be applied to control the weeds of crop plants without the use of chemical herbicides.

**4.1.8 Livestock Bedding:** Harvested leaves of vetiver can be used as livestock beddings. It is more durable than rice hay. Containing trace amount of pesticides, vetiver used as livestock bedding is more hygienic than other beddings.

## 4.2 Handicraft and Weaving

**4.2.1 The Making of Wickerworks from Vetiver Leaves:** The Thai Department of Industrial Promotion (1999) has developed a way to boil the leaves, and with a needle, remove the sharp teathed edges before using the flexible leaf to make a broad array of wonderful wickerwork products.

Similar to other natural materials commonly used in handicrafts, vetiver leaves contain high amount of fiber, thus are ideal for wicker works. They can be utilized directly to make wicker works, or interlaced into ‘basic units’ of different shapes and forms before setting up to form any particular wickerworks, or using looms to weave into mat. Other materials like rattan, wire, rod, wood, etc. may be used to support the forms.

**4.2.1.1 Direct Utilization of Vetiver Leaves:** Most wicker works can be made directly from prepared vetiver leaves without having to be made into ‘basic unit’ (see details in section 3.2.1.2 below). These include a wide range of products from handy accessories, containers, decorating materials, home appliances, and miscellaneous objects.

**4.2.1.2 Production of Basic Units:** Two types of basic units of wicker works can be made from vetiver leaves. These include: (i) *braids*, and (ii) *interlaces*.

(i) **Braids:** Braids are formed by twisting three or more threads of natural fibers such as vetiver leaves. Various patterns of braids have been developed by Thai people (see figures below)

(ii) **Interlaced Patterns:** Thai people have developed various interlaced patterns whose Thai names reflect their similarity with certain natural objects or phenomena such as flowers, seeds, animals, appliances, running water, etc.

**4.2.2 Types of Handicrafts Made from Vetiver Leaves:** Most handicrafts made from vetiver leaves are wicker works, made directly by interlacing the prepared vetiver leaves into a particular form of products, or made from braids or interlaced patterns without having to set up, like the place mat, pillow, etc. Some are, however, made by assembling braids or interlaced patterns to form an object by sewing or sticking with glue.

The Department of Industrial Promotion (DIP) has provided basic training in producing handicrafts to a number of women’s groups under the supervision of various

agencies such as the Department of Cooperative Promotion, the Department of Agricultural Extension, the Land Development Department, the Department of Public Welfare, the Doi Tung Development Project.

Handicraft products made from vetiver leaves can be grouped under following categories:

*4.2.2.1 Handy Accessories:* These are the most common group of wicker works made from vetiver leaves since the demand is quite high. These so-called 'handy accessories' include bags, hats, belts, and brooches.

*4.2.2.2 Containers:* This type of wicker works is used to put certain objects into it. It includes:

- (i) Basketry: Many forms, shapes, and sizes of baskets are produced, such as fruit baskets, winnowing baskets, utility baskets, wine baskets, and flat baskets or trays.
- (ii) Pottery: Such as pot-plant cases, wine-bottle case, etc.
- (iii) Other Objects: Tissue-paper boxes, utility boxes, etc.

*4.2.2.3 Decorative Materials:* Home decoration items, like wall clocks, picture frames, lamp-shades, dollies, animal figures, flowers, etc.

*4.2.2.4 Home Appliances:* These products are similar to home decoration objects but they are used also as appliances such as chairs, stools, room partitions, tables, etc. Mats and similar objects are also produced by weaving.

*4.2.2.5 Miscellaneous:* Such as folders, diary covers, file covers, etc.

**4.2.3 Weaving of Vetiver Leaves:** Vetiver leaves prepared for wicker works discussed above can also be used as weft to weave a wide array of products using simple hand-operated reel.

**4.2.4 The Making of Handicraft from Vetiver Roots:** It has been well known since ancient times that vetiver possesses aromatic roots. A pleasant aroma is released from vetiver root dug from the soil and hanged in the shade. In India the dried roots are used to give fragrance to linen clothes while the root mass is used as a blind to cool down the heat of the summer, especially in northern India (Sastry 1998). The blind, known as 'Tatti', is woven from the wiry, fibrous root of vetiver. The vetiver blind is continually doused with water throughout the day, turning the hot wind into a scented cooling breeze, which passes through the soaked vetiver blind, releasing a bitter-sweet aroma. The scented vetiver roots are also used for making fans, cloth hangers, and are mixed with other kind of flower scents and leaves for making sachets. An example can be cited from Thailand where fragrant cloth hangers have been produced from vetiver roots by a housewife group under the supervision of the Department of Agricultural Extension.

## **4.3 Medicinal Applications**

**4.3.1 Traditional Medicines:** Vetiver roots and leaves have been used in therapeutics treatments. An extensive review of the utilization of vetiver as medicinal plants has already been made by the senior author (Chomchalow 2001). Thai people have long known how to use various vetiver parts for medicinal purpose. People in rural areas of Thailand have used vetiver roots in the treatment to dissolve gallstones, reduce fever, and in treating diseases

related to bile and the gall bladder, and healing stomach discomfort. Lavania (2003a) described how vetiver oil was in Ayurvedic system of medicine used in India. He cited the cases of applying the oil locally to relief rheumatism, lumbago, headache, sprain (Anon. 1976), and of using infusion of roots as are refreshing drink in fever, inflammation and irritability of stomach. At ICV-3, Simon (2003) described how vetiver is used as medicinal plants in Cameroon. The diseases which vetiver has been found to be most effective are prostrate cancer, diabetes, hernia, incontinence, stomach problem, and skin conditions.

#### ***4.3.2 Therapeutic Role of Vetiver Oil:***

##### **Emotional Effects**

Vetiver oil strengthens the central nervous system. It is emotionally calming and is helpful in overcoming depression, insomnia and nervousness. Vetiver oil reduces anxiety, stress and tension. It settles nerves and can revive a person who is suffering from emotional exhaustion. Vetiver oil restores balance and harmony, brings thoughts and actions into focus and helps to stabilize energy. It normalizes either extreme sensitivity or insensitivity. Some people use vetiver oil as an aphrodisiac.

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***4.3.3 Herbal Drinks:*** In the hilly regions of Karnataka, India, people make use of vetiver roots to prepare refreshing drinking water (Sastry 1998). Chomchalow and Hicks (2001) described the method to make vetiver root drink, or 'Nam Ya Faek', a Thai traditional beverage as follows: "A handful of vetiver roots and leaves in equal proportions are boiled with four glasses of water until the liquid is concentrated down to a quarter of a glass". It is then drunk as a herbal drink.

#### **4.4 Fragrances**

The use of vetiver root for essential oil extraction to produce perfume and other fragrant materials such as potpourri, aromatic soap, aromatic wax, and aromatic kaolin, has been well known in tropical countries where vetiver grass thrives in natural condition. These countries include India, Indonesia, the Reunion Island (in the Indian Ocean), the Haiti Islands (in the West Indies), Fiji, Sri Lanka, and Brazil. Certain countries in Central America, namely Honduras, Guatemala, and Mexico, also make use of vetiver root in this manner.

In the past, Thai people made use of vetiver root as an ingredient of fragrant materials such as potpourri, hair pomade, and volatile oil for skin treatment. Such a process was passed on from generation to generation without written record. However, with the extensive production of perfumes and other fragrant material from other aromatic plants or from synthetic substances at present, the use of vetiver root as a source of fragrant materials has lost its importance.

Commercial cultivation of vetiver for oil extraction, as well as the extraction methods and properties of vetiver oil has been discussed in detail by the senior author (Chomchalow 2001). The use of vetiver as fragrant materials will be discussed under the following headings:

***4.4.1 Perfumery:*** Vetiver oil is a viscous light-brown oil, with a rich green-woody earthy and nut-like fragrance (Downwaithe and Rajani 2002). In its diluted form, vetiver

oil is used to provide sweet note and soothing cool effect. It has been utilized as raw material for various fragrant products such as perfumes, deodorants, lotions, soaps, cosmetics, etc. (Chomchalow 2001). Having a complex chemical composition and oil odor, high solubility in alcohol that improves its miscibility with other perfumery material, vetiver oil is a unique perfumery resource. Having low volatile rate, it is one of the finest fixatives known. For blending, it is used in oriental type of perfumes and floral compounds (Lavania 2003b).

**4.4.2 Aromatherapy:** Aromatherapy is the use of essential oils for therapeutic purposes. Vetiver oil has been used extensively in modern aromatherapy. It is used to balance the activity of the sebaceous oil glands as well as having deodorizing properties and helping normalize oily skin and clear acne. It also replenishes moisture in dry and dehydrated skin and has a rejuvenating effect on mature skin. It prevents stretch marks of pregnant women if applied regularly. It also strengthens the central nervous system, and can overcome depression, insomnia, anxiety, stress, tension and nervousness (Lavania 2003a). It is also used as an aphrodisiac (Wilson 1995).

#### **Beauty Benefits**

Vetiver oil balances the activity of the sebaceous glands, or oil glands, and helps to normalize oily skin and clear acne. It replenishes moisture in dry and dehydrated skin and has a rejuvenating effect on mature skin. It helps heal cuts and wounds, and soothes irritated and inflamed skin. When used regularly during pregnancy, vetiver oil reportedly prevents stretch marks. It also has natural deodorizing properties.

#### **Emotional Effects**

Vetiver oil strengthens the central nervous system. It is emotionally calming and is helpful in overcoming depression, insomnia and nervousness. Vetiver oil reduces anxiety, stress and tension. It settles nerves and can revive a person who is suffering from emotional exhaustion. Vetiver oil restores balance and harmony, brings thoughts and actions into focus and helps to stabilize energy. It normalizes either extreme sensitivity or insensitivity. Some people use vetiver oil as an aphrodisiac. Reprinted from Roberta Wilson with permission of Avery Books, a member of Penguin Putnam Inc. Copyright © 1995 by Roberta Wilson.

**4.4.3 Flavor:** In India, vetiver essence is used to flavor a soft drink (*Sharbat*), syrup, and ice cream (Lavania 2003a).

**4.4.4 Potpourri:** Potpourri is a mixture of dried flower petals with spices, kept in a jar for its fragrance. Chopped, dried vetiver roots can be made into potpourri by mixing them with dried fragrant flower petals and spices.

### **4.5 Construction-related Activities**

**4.5.1 Roof Thatch:** Thai people, as well as people living in rural areas of Asia have long utilized vetiver culms and leaves for roof thatching in the same way as nipa palm leaves. Vetiver grass has a better quality for roof thatching than cogon grass because the culms and leaves of vetiver are coated with wax, and have a unique scent that repels insect and fungal attacks. The durability of a vetiver thatch depends on the neatness of thatch making. The thatches with more or denser vetiver grass will be more durable. The manner in which the thatches are laid on the roof also matters. For example, on a steep roof like that of a traditional Thai house, vetiver thatches can be more durable than on a flatter-roofed structure. Vetiver has also been used as roof thatch in several other countries in

Africa where thatch is vital for roofing of many rural houses (Grimshaw 2002a). In Ethiopia, vetiver has replaced the traditional thatching grass in some areas as it lasts longer and makes a more rain-proof roof (Anon. 1990a).

**4.5.2 Hut:** In Senegal, native vetiver (*Vetiveria nigriflora*) leaves are used in the building of simple huts (Juliard, pers. comm.). In India, dried roots of vetiver have been used since ancient times for making makeshift huts and cabins as they provide cooling effects during the summer (Lavania 2003a).

**4.5.3 Mud Bricks:** Juliard (pers. comm.) reported that, in Senegal vetiver is used in mud-brick making as it reduces cracking. This is confirmed by Goudiaby *et al.* (2003) who reported that when vetiver leaves are mixed in clay to make 'adobe' type dried bricks, it prevents walls from cracking.

**4.5.4 Prefabricated Vetiver-Clay Blocks:** At ICV-3, Hengsadeekul and Nimityongskul (2003a) of the Asian Institute of Technology, reported on the experimentation of making prefabricated vetiver-clay blocks for use as construction materials, starting with material preparation, laying vetiver-clay composite in mold, pressing process, remolding and turning face up on designed support plate, sun drying, dry heating, and block laying steps with clay slurry as wall panel. They concluded that vetiver could be used with clay composite for substituted bricks and columns for housing construction. The prefabricated wall has rather low thermal conductivity which makes it comfortable and energy saving. It is truly a labor-based appropriate technology.

**4.5.5 Vetiver-Clay Composite Silo:** Vetiver can be used as raw material for the construction of low-cost storage bin. At Chitralada Palace in Bangkok, a grain silo made of vetiver-clay composite was piloted (Nimityongskul and Hengsadeekul 2002; and Hengsadeekul and Nimityongskul 2003b). The silo has a diameter and height of 3m. It is about 1.2m above the ground and its capacity is 20m<sup>3</sup>. Its foundation was constructed with reinforced concrete, while its ground wall and slab were built with cement-block filled with reinforced concrete. The silo walls were constructed with vetiver-clay bundle, coated with cow-dung mixed with clay and rice husk, while its roof was of bamboo structure thatched with vetiver bundle overlaps. A structural component for ventilation that reduces moisture and temperature forms part of the proposed structure.

**4.5.6 Cement Replacement Material:** Vetiver ashes have been experimentally used as low-cost, environmental-friendly, and energy-saving construction material. At ICV-3, Nimityongskul *et al.* (2003) reported on the experiment of using vetiver grass ash (VGA) as a new building material specifically for the rural areas of the developing countries. The properties of VGA were investigated in order to consider the possibility of using it as a pozzolanic material. The physical and mechanical properties of VGA and cement mortar containing VGA were also determined. They concluded that it is possible to use VGA as a cement mortar.

**4.5.7 Particle Board and Panel:** The Royal Project Foundation (Thailand) was successful in making board and veneer from vetiver root mass to substitute wood in making furniture and interior decorative appliances, while a company in Thailand is successful in producing vetiver board from the leaves of vetiver. Various other vetiver products have been produced commercially ([www.golden-board.com](http://www.golden-board.com)). The advantages of these products are that they are beautiful, durable and practical. Above all, they are made from vetiver leaves, which are the by-product of

growing vetiver cultivation for soil and water conservation, and a means of conservation of the natural forest as these products are a good wood substitution.

Panichnava and Nimityongskul (2003) investigated the physical and mechanical properties in the making of the particle board from vetiver and suitable adhesives by utilizing locally available materials. Three adhesives - urea formaldehyde, polyvinyl acetate, and corn starch - were investigated to determine the optimum mix proportion for the making of vetiver boards. The fabrication of these boards was done by mixing vetiver with adhesives and keeping them in appropriate formwork. These formworks were tightly sealed from all sides and the pressure of 80 kg/cm<sup>2</sup> was applied which varied from 8 to 21 hrs depending upon the type of adhesive used. The vetiver boards possessed high water absorption and thickness swelling; hence not making them waterproof. The boards made from urea formaldehyde based adhesive were expensive as compared to the other adhesives. The ones made from corn-starch-based adhesive were the cheapest.

#### **4.5.8 Veneer and Fiber Board:**

**4.5.9 Straw Bale:** Straw bales are used in building construction. The concept of using straw bales with cement facing in building construction has been accepted by the fire authorities in a number of countries. The technology reduces costs greatly and provides excellent insulation. Pease (2002b) described the straw bales that were made from vetiver leaves; the bales are almost free from insect as the vetiver possesses repelling chemicals in it.

**4.5.10 Termicides:** Many products of Vetiver were put to experiment for their value as insect repellent and particularly for termicide. The on going project is launched by RFD and NRTC.

### **4.6 Containers**

Many kinds of containers can be made from vetiver. Among these are:

**4.6.1 Pottery:** In Senegal, artisans have made some pottery by mixing chipped vetiver mixed with clay, giving the finished non-fired product a nice earthy texture (Juliard, pers. comm.). In Thailand, a project on the production of vetiver pots has been initiated by the Doi Tung Development Project. The pots are low-priced and environmental friendly as they disintegrate after few months. Thiramongkol and Baebprasert (2002) have experimentally produced vetiver pot to be used as containers for plants prior to planting operation. The vetiver pot is made of clay, dry vetiver grass leaves and a binder (polyvinyl alcohol or 'Pival'), which is safe for soil and water. After hardening and planting in the pot, the potted plant is put directly into the ground without removing the pot. Production process includes mixing of clay with dry vetiver leaves, then mix with water and 'Poval' by extruder, jigger. Leave it in the plaster mold for 30 min, then take it out off the mold. Vetiver pots possess the unique property of allowing the user to plant any kind of plants, from vegetables to trees, without the trouble of removing the pot before planting.

At ICV-3, Thiramongkol *et al.* (2003) reported on the investigation on making glazed ceramic pots of various colors from vetiver and clay at the proportion of 1:10 and fired at 1,200°C. The pot is light-weight with good aeration on the surface, thus enhancing maximum benefit for growing orchids and other ornamental plants.

**4.6.2 Water Containers:** These are based on the same principle as the vetiver-clay composite storage silo in # 3.5.5, but built on ground level, and used as water containers or small fish ponds.

**4.6.3 Melamine Utensils:** The Royal Project Foundation has attempted to produce melamine utensils from vetiver leaves. The products are of good quality.

## **4.7 Energy Sources**

Two forms of energy sources can be made from vetiver, namely:

**4.7.1 Ethanol:** Kuhirun and Punnayak (2000) described the process of producing ethanol from vetiver leaves. Dry leaves were first pretreated with alkali. The simultaneous saccharification and fermentation (SSF) technique was used to convert plant residues into ethanol. The cellulase enzyme for SSF was prepared from *Trichoderma reesei*; this enzyme activates specific reaction for the release of glucose for fermentation into ethanol. The addition of alkali-pretreated leaves, cellulase enzyme, and fermentation yeast at 40°C, pH 5.0, for seven days yielded ethanol. By using a one-cycle column distillation, the ethanol yield was 13%. The ethanol produced was clear in color with a slight pleasing odor.

**4.7.2 Green Fuel:** Broken vetiver culms and leaves that cannot be utilized for other purposes can be mixed with water hyacinth, as a mixer, in a proportion of 3:2 (Babpraserth *et al.* 1996). Then compress the mixture into shafts with a cylinder-shaped fuel squeezer, 1.7 cm in diameter. Fuel shafts can burn easily and produce little smoke, but yield high temperature. For example, it takes 5 min. to boil 1L of water, and the fuel still keeps on burning for up to 28 min.

## **4.8 Pulp and Paper**

Vetiver can be used as a raw material for making pulp and paper. In India, studies that were carried out at the Forest Research Institute, Dehra Dune, revealed that pulps suitable for making strawboards can be made from vetiver by digestion with lime (Anon. 1976). Vetiver has a high content of hemicellulose; its cellulose content is 45.8% (DW). Pilot-plant trials have indicated that vetiver yields a chemical pulp that can be used for making writing and printing papers. Containing short fiber, the pulp has to be used in admixture with 30-40% of a long-fibered pulp.

## **4.9 Bouquet**

Bundle of cut vetiver leaves, together with the culms bearing inflorescences, can be used as materials of a bouquet, or decorative plant in containers such as vase, pot, etc. for display. Examples can be seen in the decoration on the stage at ICV-3 in Guangzhou, China.

## **4.10 Household Appliances and Souvenir**

**4.10.1 Furniture:**

**4.10.2 Household Appliances:**

**4.10.3 Souvenirs:**

#### **4.11 Mattress and Other Stuffing**

In Ethiopia, vetiver has been utilized as a primary material for mattress stuffing (Anon. 1990a). In India, vetiver roots are used a stuffing material in ventilating panels used in electric desert coolers.

#### **4.12 Coolant**

In India, the vetiver root have been used since ancient times for making woven screens, mats, blinds, hand fans, broom hangers, and baskets. When sprinkled with water and hung at the proper ventilating space, such materials provide cooling effect and pleasant aromatic air (Lavania 2003). They are also used on car rooftops to provide a cooling effect. In outer Delhi, India, poultry farmers kept their large poultry houses cool using desert coolers and heat exchange by forcing air though 'wet mats' made from woven vetiver roots (Greenfield 2003).

#### **4.13 Brooms**

### **5. Discussion**

#### **5.1 Main Objective of Growing Vetiver**

It must be stressed that the main objective of growing vetiver is for soil and water conservation in agricultural and non-agricultural applications. Other related uses such as for environmental protection, heavy metal absorption, embankment stabilization, etc. have also been envisaged. His Majesty the King of Thailand has repeatedly summoned that uses other than the ones just mentioned, as well as the utilization of harvested material, should not be overemphasized to nullify the main uses of vetiver.

#### **5.2 Growing Vetiver as a Cash Crop for Vetiver Oil Production:**

**5.2.1 Growing in the Field:** World demands for vetiver oil have increased somewhat in recent years due to the shortage of supply from producing countries such as Indonesia, Haiti, India. This may be largely attributable to the increased use of vetiver oil for aromatherapy. This increase, however modest, in cash income from vetiver has both positive and negative aspects. Positively, the cash income could attract small-scale farmers to plant vetiver hedgerows where a market for oil exists. Negatively, there is the danger that farmers could remove plants from a soil conservation barrier for cash earning and, thereby, destroy the soil and water conservation attributes of the hedgerow barrier. In this connection, Pease (pers. comm.) proposed that planting of vetiver as a double hedgerow would help, especially the small holders. With a double hedgerow system, one hedge would be harvested, say every two years for oil extraction from the roots, leaving the other to act as the soil and water conservation barrier. The harvested hedge would then be replanted and the system continued *ad infinitum*.

**5.2.2 Growing in Bags or Other Containers:** The senior author (Chomchalow 2001) described an experiment conducted in Thailand of growing vetiver in black polyethylene bags that yielded approximate half a kilogram of dry root within one year having 1% oil. The advantage of this system of growing vetiver in sand-based medium in large polybags

is that harvesting is much more efficient than growing in the field, and can make efficient use of degraded land since the land is only used to lay polybags on.

### **5.3 Ecological vs Economic Benefit of Growing Vetiver**

There is no question that vetiver has a considerable ecological benefit in soil and water conservation, as well as environmental protection. Its hidden economic value of an inexpensive means of stabilizing back-slopes and side-slopes of the highways, railroads, as well as earthen dams is also increasingly being recognized. Increasing awareness of the ecological potential of vetiver in controlling pollution, and in protecting our environment such as in wastewater treatment, heavy metal contamination, etc. are likely to be envisaged in the near future.

To small-scale farmers, however, these somewhat intangible benefits may be difficult to be recognized. It is a challenge to the extension services to persuade farmers of the long-term ecological benefits of soil conservation and the much more immediate economic benefits of crop yields that are rapidly discernible in retaining soil moisture and plant nutrients between hedgerow. It is difficult for a small-scale farmer to allocate some of his scarce land resource to the planting of a vetiver hedge as this would remove the land from his subsistence agricultural production.

### **5.4 Industrial Potential of Vetiver Products**

#### ***5.4.1 Particle Board:***

***5.4.2 Botanical Pesticides:*** The authors are intrigued by the proposal of Pease (pers. comm.) that if “a packaged mulch product were to be made from the dried, chopped roots and tops that could be used to kill or repel common garden pests and termites that could substitute for insecticides and fungicides. The mulch product could be used domestically by the farmers themselves for their needs, particularly for producers of certified ‘organic’ crops. Perhaps the mulch product could be exported in a compressed form to European and North American markets”.

There was a report from Louisiana State University (Maistrello and Henderson 1999) that one of the components of vetiver oil kills the Formosan termite. It would be great if a mulch of vetiver roots and leaves could substitute some harmful insecticides. The farmers could grow their own supply and use it on their own plots.

### **5.5 Integrated Pest Management**

Van den Berg, *et al.* (2003) are of opinion that if vetiver can act as an insect trap as described in #2.4.5, an important tool is available to persuade the farmers to use vetiver on their fields for both soil and water conservation as well as for insect control and management. Vetiver would be an Integrated Pest Management tool with a difference! It should be noted that if cut regularly, vetiver leaves makes a good mulch (see #3.1.1) that is reported to control white fly.

All field staff are urged to test the effectiveness of vetiver for stem borer control on all cereal crops as soon as possible. If it is confirmed that vetiver is doing the job as an insect trap, then we have an important tool to persuade farmers to use vetiver on their fields for both soil and water conservation and insect control. Vetiver would be an IPM (Integrated Pest Management) tool with a difference! Remember also that if cut regularly,

vetiver leaves provide excellent forage and also make a good mulch that is reported to control white fly.

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