Vetiver Grass for Manifold Uses: A Critical Review

Dhirendra Kumar, Kumar Nikhil

Abstract—**Vetiver (Vetiveriazizanioides) grass is well known in the India, used as khus in cooling, medicinal oil, manufacturing of many medicine, fragrance, foods preservatives and refrigeration in the preparation of many types of liquids. The grass is tasteful, earthly flavour. This a herb has a cooling effect like mint or peppermint. Vetiver grass is tall, aciform, everlasting, scented with a long straight stem with narrow leaves, fibrous root system found in abundantly. It has manifold uses as an inexpensive, effective and eco-friendly tool to conserve soil erosion and moisture. This belong to medicinal and aromatic plants groups having parts consist of chemical ingredient which are active in curing ailments with providing tasteful flavours. Yield as vetiver leaves, culms and roots was used after processing as input in agricultural activities (mulch, compost, nursery block / planting medium, animal feed stuff, mushroom cultivation, botanical pesticides, and allelopathy), handicraft works, medicine, fragrance, input in construction activities (roof thatch, hut, mud brick, vetiver-clay composite storage bin, veneer / fiber board, artificial pozzalans, ash for concrete work, and straw bale), in containers (pottery, melamine utensils, water containers), bouquet, energy sources (ethanol, green fuel), industrial products (pulp and paper, panel), and many other uses. This is a review paper in which a brief description has been given on the Vetiver Grass Technology (VGT) includes whole bunch of technological solution for the sustainable development of our country.**

Index Terms—**Vetiver grass, reclamation, soil conservation, socioeconomic uses and VGT.**

I. Introduction

Vetiver (Vetiveriazizanioides) grass is perennial in nature and tall grows wild in semiarid and arid with climatically versatile situations in India (Alam, et.al, 2005). Agronomically it has spongy, branched root system with fine rootlets, oil being extracted for perfume. The dry aromatic roots are used to make curtains, mats, fans and other fancy goods as the product emits a sweet cooling aroma for a long period when moistened during summer season (Alam, et.al., 2005). The oil is used for blending of perfumes, cosmetics and scenting of soaps. Its cultivation is largely scattered all over India. The Vetiver Grass System (VGS) is a system of soil and water conservation whose main component is the use of the vetiver plant in hedgerows (Nikhil, et.al., 1998).

The Vetiver Grass System famous in many countries for soil and water conservation (Nikhil, 2003 and Nikhil, 2002), infrastructure stabilization, pollution control (Nikhil, 1999, 2004), waste water treatment (Nikhil, 2005a,b), mitigation and rehabilitation (Nikhil, 2001), sediment control (Nikhil, 2004), prevention of storm damage, and many other environmental protection applications through bioengineering and phytoremediation process.

The vetiver grass is the main component to all Vetiver System for bioengineering and conservation applications used in the tropics and semi-tropics, and areas that have a Mediterranean climate where there are hot summers, and winters are temperate. Combined with a deep and strong root system, a wide range of pH tolerance from about pH 3 to pH 11, tolerance to most heavy metals, ability to remove excess nitrates, phosphates and farm chemicals from soil and water (Truong and Baker 1997, 1998). The vetiver plant can be used for soil and water conservation, engineered construction site stabilization, pollution control (constructed wetlands), and other uses where soil and water come together (Singh, et.al., 1998).

Vetiver grass reduces rainfall runoff by 70% and sediment by 90% because of low-cost, labor-intensive with high benefit/cost ratio. The Vetiver System is a developing technology for soil conservation and more recently a bioengineering tool with effective application of Vetiver System which have significant engineering design and construction requires an understanding of every sectors (Nikhil, et.al., 1998).

II. Background

In coal mining areas the land is degraded due to continuous mining resulting soil erosion. The practices of continuous mining destroys the quality of land and damages the total environmental scenarios of that area. Algae and other aquatic plants like vetiver grass can be used for the reclamation of these created wastelands (Nikhil and Sunil. 2012; Ansari and Nikhil, 2014a, b) and Nikhil, 2014). The use of vegetation for erosion control and slope stabilization have been used for centuries (Intaphan et al. 1997). Its popularity has increased in the last two decades. Whereas, over coal mining overburden dumps slopes plantations of vetiver grass not only add biomass but also preserve top spreaded soil from erosion (Nikhil, et.al., 2002and Nikhil, et.al., 2001). This is partly due to the low costs, vegetative approach and more knowledge and information on vegetation are now available for application in engineering designs. In addition to vetiver is also highly tolerant to adverse growing conditions such as extreme soil pH, temperatures and heavy metal toxicities (Truong et al., 1995 &Hengchaovanich, 1998). Vetiver Grass Technology (VGT) involves the correct application of this grass in erosion and sediment control, land stabilization, mining rehabilitation and flood mitigation (J.M 1992 & R. Mahadevan, 2008).VGT for slope stability enhancement and erosion control on highways, railways, stream banks etc. The use of vegetation as a bio-engineering tool for erosion control and slope stabilization (Nikhil and Loveson, 1998) and due to the low costs of bio-engineering techniques (Truong et al., 2008), and vegetative approach. Land disturbance by construction activities has resulted in soil erosion increases from two to fortythousand times the pre-construction rates

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1. Dhirendra Kumar, M.Sc. in Environmental Science, School of Energy, Environment and Earth Science, Central University of Kerala, Tejaswani Hills, periya (PO), Kasaragod (DT), Kerala-671316, India;dhrusingh93@gmail.com;+91 7677329666(M)
2. Dr. Kumar Nikhil, Principal Scientist, CSIR-CIMFR, Barwa Road, Dhanbad-826001, Jharkhand, India; nikhilnathsinha@gmail.com; +91 9835568089(M)

(Goldman et al, 1986 and Donjadee et.al., 2010) with sediment being the principal transport mechanism for a range of pollutants entering water courses (Kingett, 1995). Its real impact on land stabilization, soil erosion and sediment control only started in the late 1980's following its promotion by the World Bank. Besides this, vetiver can purify mine water in the mine effluent pond and can be used for agricultural purposes (Ashutosh and Nikhil, 2014 and Pawan, et. al., 2015).

III. AGRONOMICAL PRACTICES ADOPTED

The Vetiver grass has been grown and extensively used for vetiver oil worth. The vetiver grass is a native of India and is found throughout the plains and lower hills of India. It is systematically cultivated in most of the state of our country as it's have wide adoptability.

3.1 Climate and Soil:

Vetiver prefers a mild climate but can be grown under both wet and dry or arid and tropical conditions (http://www.agriinfo.in/default.aspx?page=topic&superid=2&topicid=1403).

3.2 Planting:

There are three different Method of planting adopted by different growers.

a) Methord1:

Conical ridges, 30-38 cm high and 48 cm apart are made at the summit and the slips planted 23 cm apart on the summit.

b) Method II:

The land is laid out in to beds of 30 cm high, 68 cm wide and 45 cms apart edge to edge and the slips are planted on these in two rows 22.5 cm apart, leaving 22.5 cm on either sides.

c) Method III:

The beds are made 45 cm high, 60 cm wide and 30 cm apart edge to edge and two rows, 30 cm apart, are planted on these leaving 15 cm on either side. The spacing within the row is also 30 cm in this system. Tillers take long time for growing and therefore, slips are the better planting materials for propagations (Intaphan et al., 1997; Jimbaand Adedeji 2003). The slips are planted in pits, 5 to 8 cm deep made with a pointed stick. Two or three slips are planted in each hold. One hectare requires 1, 50,000 to 2, 25,000 slips with 2 - 3 slips per pit in the commonly adopted system of planting (2^{nd} method) (N. Dudai et. al., 2005). The best planting time June-July.

3.3 Manures and Fertilizers:

Generally, application of groundnut cake or cattle manure or wood has a beneficial effect on the yield of roots. Application of 22.5 kg P205 and 22.5 K20 is optimum to get higher yield.

IV. ADOPTABILITY

4.1 Habit:

Vetiver grass grows up to 2 m high with a strong, dense and vertical root system measuring <3 m, hydrophyte, thrives under xerophytes conditions (Truong, 1999). Best adoptability is with temperature mean m18-25^{o} C, mean coldest month 5^{o} C, absolute minimum15^{o} C and plants die when ground frozen. Summer Temperature should < 25^{o} C is required for good growth. Rain fall is low as 300 mm, but above 700 mm preferable will survive total drought, but normally requires a wet season of at least three months. Ideal is well spread monthly rainfall. Humidity: Grows better under humid conditions, but also does well under low humidity. *Sunshine:* Difficult to establish under shade, when shade is removed growth recovery is rapid. Soil: Grows best on deep sandy soils, however, it will grow on most soil types ranging from black cracking vertisols through to red alfisols. Grows on rubble, both acid (pH3.3) and alkali (pH9.5), Grows on both shallow and deep soils (Truong, 1999). Up to about 2,000 m. above 2000 m altitude vetiver growth may be constrained by low temperatures (Babalola O. et al., 2007).

4.2 Morphological characteristics:

Vetiver grass does not have stolons or rhizomes. Its massive finely structured root system can grow good, in some applications rooting depth can reach 3-4m in the first year (Truong, 2002). This deep root system makes vetiver plant extremely drought tolerant and difficult to dislodge by moving of strong water (Truong et al., 1995 &Hengchaovanich, 1998). Stiff and erect stems that can stand up to relatively deep water flows, Highly resistance to pests, diseases and fire, A dense hedge is formed when planted close together acting as a very effective sediment filter and water spreader, New shoots develop from the underground crown making vetiver resistant to fire, frosts, traffic and heavy grazing pressure and New roots grow from nodes when buried by trapped sediment. Vetiver will continue to grow up with the deposited silt eventually forming terraces, if trapped sediment is not removed.

4.3 Physiological characteristics

Tolerance to extreme climatic variation such as prolonged drought, flood, submergence and extreme temperature from -14ºC to +55ºC (Truong P. et al., 2014). Ability to re-grow very quickly after being affected by drought, frosts, salinity and adverse conditions after the weather improves or soil ameliorants added, Tolerance to wide range of soil pH from 3.3 to 12.5 without soil amendment, High level of tolerance to herbicides and pesticides, Highly efficient in absorbing dissolved nutrients such as N and P and heavy metals in polluted water, Highly tolerant to growing medium high in acidity, alkalinity, salinity, sodicity and magnesium and Highly tolerant to Al, Mn and heavy metals such as As, Cd, Cr, Ni, Pb, Hg, Se and Zn in the soils (Singh and Sinha, 2004, Yang et.al., 2013 & Zhang et al., 2014).

4.3 Ecological characteristics

Although vetiver is very tolerant to some extreme soil and climatic conditions mentioned above, as typical tropical grass, it is intolerant to shading. Shading will reduce its growth and in extreme cases, may even eliminate vetiver in the long term. Therefore vetiver grows best in an open and weed free environment, weed control may be needed during establishment phase. On erodible or unstable ground vetiver first reduces erosion, stabilizes the erodible ground (particularly steep slopes), then because of nutrient and moisture conservation, improves its micro-environment so other volunteered or sown plants can establish later (Truong 2002). Because of these characteristics vetiver can be considered as a nurse plant on disturbed lands.

4.4 Cold weather tolerance of vetiver grass

Although vetiver is a tropical grass, it can survive and thrive under extremely cold conditions. Under frosty weather its top growth dies back or becomes dormant and 'purple' in colour under frost conditions but its underground growing points survived. In Australia, vetiver growth was not affected by severe frost at –14ºC and it survived for a short period at –22ºC (-8ºF) in northern China. In Georgia (USA), vetiver survived in soil temperature of -10ºC, but not at –15ºC. (Paul Truong, 2000-2008) Recent research showed that 25ºC was optimal soil temperature for root growth, but vetiver roots continued to grow at 13ºC. Although very little shoot growth occurred at the soil temperature range of 15ºC (day) and 13ºC root growth continued at the rate of 12.6cm/day, indicating that vetiver grass was not dormant at this temperature and extrapolation suggested that root dormancy occurred at about 5ºC.

V. YIELD

In this paper results of the uses of vetiver grass to improve the water holding capacity and moisture percentage of soil in wastelands. Water holding capacity and moisture percentage are the two important soil factors governing the productivity (Chen et al., 1994; Lu and Zhong, 1997). Vetiver grass was grown in an area with known water holding capacity and soil moisture percentage for 20 months (Priyadarshani et. al., 2013). A control plot was maintained without vetiver grass. Soil samples were collected once in a month in control and treated plots. Water holding capacity and soil moisture percentage were determined by standardized methods. When compared with control plots, the treated plots show 20% increase in water holding capacity & soil moisture percentage over control. Positive correlation were made between root biomass and the two soil parameters studied (Morin et al., 1981; Ben-Hur and Letey, 1989). Fine roots significantly influence soil organic matter accumulation and nutrient cycling. Characterization of the activity of the fine roots is therefore a key approach to the understanding of the below ground system (Singh, 1998). At the global level, fine root production represents a large and relatively unknown portion of the production/decomposition carbon balance. Despite the central importance of fine root dynamics neither a clear and consistent pattern of fine root dynamics in communities nor an understanding of factors controlling those dynamics has emerged. Very little information is available on this subject. The present study on fine root productivity of vetiver was designed to unravel temporal and spatial patterns of their size distribution, growth, decomposition and overall role in the functioning of the below ground system (Nikhil et al., 2004). Root sampling involved collection of replicate soil cores, hand washing and sorting of roots from the soil matrix. Collections were made at monthly intervals. Ten randomly spaced samples (1.9 cm in diameter and to a depth of 15 cm) were collected separately in the study area. (l8 months old stand of vetiver). Annual fine root production of vetiver is estimated by max-min method of (McClagherty et al., 1982 & 1994).The annual fine root biomass was 190 kg/ha. Positive correlation was obtained between fine root biomass and organic carbon content of soil.

Soil-erosion is a serious cause of ecological disturbances and environmental degradation. Its impact is more distressing in resource-poor countries which can hardly afford mechanical control of soil-remediation (Babalola et al., 2000).

VI. ECONOMICS OF CULTIVATION

According to some research, Cost and returns in vetiver roots production the results in respect of cost and returns in vetiver roots production are presented. Pattern of employment in vetiver root production the results of the labor employed in vetiver root production per acre are presented. Inputs utilization pattern in vetiver roots production. The results in respect of the average quantities of inputs used per acre of vetiver roots production are presented. In vetiver roots production, on an average farmers used 3000 slips for rising nursery for one acre. The FYM used at the rate of three tons per acre and fertilizer in terms of nutrients, nitrogen (N), phosphorus (P) and potash (K) were 119.70 kg, 123.90 kg and 103.00 kg respectively (Kumar Nikhil 2004 and Priyadarshani et al. 2013). On an average the farmers had used 400 ml of plant protection chemicals. Around 159.7 man days of human labour and 10.50 machine hours were utilized per acre by the respondents. For irrigating nursery field 30 liters diesel used. Cost structure in vetiver roots production the costs incurred per acre of vetiver roots production are presented. Among the variable cost, expenditure on labour was Rs. 31,830 which accounts for 61.73 per cent of total cost and it was the major cost in vetiver roots production of which cost on human labour was Rs. 23,955 (46.46% of the total cost), cost on machine hour was Rs. 7875 (15.27%), Cost on FYM was Rs. 1500 which accounts for 2.90 per cent of the total cost. The amount spent on slips for rising nursery was Rs. 4500 which accounted 8.72 per cent of the total cost. The internal rate of return was 72 per cent. Benefit – cost ratio (B: C) indicates the returns per rupee invested in vetiver processing unit which was 1.45. Payback period (PBP) is the time required to recover the initial investments made on vetiver processing unit. It is seen that the payback period was 1.66 years.

VII. MANIFOLD USES

Medicinal and Health Benefits of Vetiver Essential Oil The health benefits of Vetiver Essential Oil can be attributed to its properties like anti-inflammatory, anti-septic, aphrodisiac, cicatrisant, nervine, sedative, tonic and vulnerary. This Essential Oil is very popular in aromatherapy and has many medicinal properties, which are described in brief below.

7.1 Anti Inflammatory:

The very soothing and cooling effect of this essential oil calms and pacifies all sorts of inflammations. But it is particularly good in giving relief from inflammations in circulatory system and nervous system. It is found to be an appropriate treatment for inflammations caused by sun stroke, dehydration and loo (name given to very hot and dry winds prevalent during summers in the dry regions of India and few neighbouring countries).

7.2 Aphrodisiac:

Mixed in sorbets and beverages as a flavouring agent, this oil has an aphrodisiac effect. It enhances libido and gives arousals. Since sex has more to do with the psychology (brain) than the physiology, remedy for most of the sexual disorders like frigidity, lack of libido, impotence etc. lays in the brain. Certain components of this oil stimulate those portions of brain and the problems are over.

7.3 Cicatrisant:

Cicatrisant is a property by virtue of which a substance speeds up the eradication or disappearance of the scars and other marks from the skin. It promotes growth of new tissues in the affected places which replace the dead and discoloured tissues and helps achieve a uniform look. This is also useful for the post-delivery stretch marks, fat cracks, after spots left by pox, burns etc.

7.4 Fungicides:
In New Zealand, 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.

7.5 Agaricides:
In Thailand, 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.

7.6 Herbal skin care use
Vetiver in recent years have been used to produce perfumes, creams and soaps. It is used for its antiseptic properties to treat acne and sores.

7.8 Soil and water conservation, Erosion control
Several aspects of vetiver make it an excellent erosion control plant in warmer climates. Rows of plants oriented perpendicu-larly to the slope direction has used as semipermeable barriers that reduce the surface runoff, amount of infiltrated water increases and the runoff and soil loss amounts decrease (Wakindiki and Ben-Hur, 2002b). This makes vetiver an excellent stabilizing hedge for stream banks, terraces, and rice paddies, and protects soil from sheet erosion. The roots bind to the soil, therefore it cann't dislodge. Vetiver has also been used to stabilize railway cuttings/embankments in geologically challenging situations in an attempt to prevent mudslides and rockfalls, the Konkan railway in Western India being an example. The plant also penetrates and loosens compacted soils. The Vetiver system, a technology of soil conservation and water quality management, is based on the use of the vetiver plant.

7.9 Runoff mitigation and water conservation
The close-growing culms also help to block the runoff of surface water. It slows water's flow velocity and thus increases the amount absorbed by the soil (infiltration). It can withstand a flow velocity up to 5 metres per second (16 ft/s). Vetiver mulch increases water infiltration and reduces evaporation, thus protects soil moisture under hot and dry conditions. The mulch also protects against splash erosion (T. Umezawa, et al. 2006; H. Nayyar et al., 2006 & M. Seki et al., 2007).

7.10 Crop protection and pest repellent
Vetiver can be used for crop protection of. physical and biological measures of erosion control such as contouring, tillage, soil mulching, terracing, alley-cropping, agroforestry, crop rotation, bunding and tied-ridging have been used to varying degrees and successes in Nigeria, depending on localities (Lal, 1981; Aina, 1989).The essential oil of vetiver has anti-fungal properties against Rhizoctoniasolani Kuhn. As a mulch, vetiver is used for weed control in coffee, cocoa and tea plantations. It builds a barrier in the form of a thick mat. When the mulch breaks down, soil organic matter is built up and additional nutrients for crops.

7.11 Vetiver as a termite repellent
Studies by Prof. Gregg Henderson found that vetiver extracts could repel termites. However, vetiver grass alone, unlike its extracts, cannot be used to repel termites. Henderson planted vetiver in trash cans and hammered wooden stakes into the soil filled cans. He offered large population of termites the ability to move into the trash cans via another trash can, but found that although the vetiver root completely filled the cans in 6 months, the stakes were still attacked. The termites had moved around the roots and got to the wood. Unless the roots are damaged, the anti-termite chemicals, such as not atone, are not released. Henderson reports that his research on the idea of protection of a home with vetiver planted as a barrier ended at that point. Another study found a similar result.

7.12 Animal feed
The leaves of vetiver are a useful byproduct to feed cattle, goats, sheep and horses. The nutritional content depends on season, growth stage and soil fertility. Under most climates, nutritional values and yields are best if vetiver is cut every 1–3 months (Nguyen Van Hon, 2004).

7.13 Food and Flavorings
Vetiver (Khus) is also used as a flavoring agent, usually through khus syrup. Khus syrup is made by adding khus essence to sugar, water and citric acid syrup. Khus essence is a dark green thick syrup made from the roots of khus grass (vetiver grass). It has a woody taste and a scent characteristic of khus. The syrup is used to flavor milkshakes and yogurt drinks like lassi, but can also be used in ice creams, mixed beverages like Shirley Temples and as a dessert topping. Khus syrup does not need to be refrigerated, although khus flavored products may need to be.

7.14 Medicinal use
Vetiver has been used in traditional medicine in South Asia (India, Pakistan, Sri Lanka), Southeast Asia (Malaysia, Indonesia, Thailand), and West Africa. Old Tamil literature mentions the use of vetiver for medical purposes (John axe, 2003).

7.15 In-house use
In the Indian Subcontinent, khus (vetiver roots) is often used to replace the straw or wood shaving pads in evaporative coolers. When cool water runs for months over wood shavings in evaporative cooler padding, they tend to accumulate algae, bacteria and other microorganisms.

7.15 Fuel cleaning
A recent study found the plant is capable of growing in fuel-contaminated soil. In addition, the study discovered the plant is also able to clean the soil, so in the end, it is almost fuel-free.

7.16 Other uses
Vetiver grass is used as roof thatch (it lasts longer than other materials), mud brick-making for housing construction, strings andropes and ornamentals (for the light purple flowers). Garlands made of vetiver grass are used to adorn the murti of Lord Nataraja (Shiva) in Hindu temples. It is also a favourite offering to Ganesha. Vetiver oil has been used in an effort to track where mosquitoes live during dry seasons in Sub-Saharan Africa. Mosquitoes were tagged with strings soaked then released. Due to its fibrous properties, the plant can also be used for handicrafts, ropes and more (Truong., P, et. al., 2013).

VIII. CONSTRAINTS

The major problems were high cost of production (95%), high labour cost (93.33%), and low yield of vetiver roots (91.66%), shortage of labour (83.33%), decrease in soil fertility (83.33%), non-availability of genuine planting material (75%), lack of extension education (58.33%), prevalence of pest and disease (41.66%) and lack of support from the government (33.33%). It could be noticed that nonexistence of a separate local market for selling the vetiver oil was the main problem for both small scale and medium scale processors which was expressed by respondents due to which processors highly dependent on brokers and handling of brokers for sale of oil was a tough task for the processors. Production costs of vetiver oil are high, according to both small scale and medium scale processing unit's owner's opinion. This was mainly because of higher price for raw material (vetiver roots). They also felt that non availability of fuel wood at cheaper price due to strong opposition from forest officials for cutting trees. Non availability of quality raw material was another major difficulties faced by both small and medium scale processors that led to lower yield of vetiver oil. High sale tax on vetiver oil sale was another problem faced by medium scale processing owner. A high electricity bill was another constraint in medium scale processing unit. It was because, a commercial rate of electricity was charged for this processing unit, whereas for agriculture and other operations there are some subsidies on electricity power supply. Subsidy on power supply for this unit may be extended to support the production and processing of vetiver oil. Problem in getting subsidy on initial investment was another problem expressed by the medium scale unit owners (Sunil, June 2011).

IX. FUTURE SCOPE

Chrysopogonzizanioides - is a tropical clump grass with origin in south India. It has the ability, when planted close together in a line, to create a near perfect barrier that filters out sediment, spreads rainwater, improves the shear strength of soil, and recycles soil nutrients. Vetiver has a wide range of applications, and the common domesticated cultivars used around the world are non-invasive. The plant will virtually grow anywhere except where the winter temperatures result in perma-frost and summers are too mild. Thus its main areas of growth are in the tropics and semi tropics, Mediterranean climates, and in arid regions (when there is available supplementary water). Its primary uses are for soil and water conservation, soil fertility enhancement, bio-engineering, phytoremediation of contaminated land and water, disaster mitigation, and a bio-product supply for forage, fuel, handicrafts, and perfumery (Truong, 2002 & Xia, 2004). It also sequesters significant quantities of atmospheric carbon. Since most major applications require a large number of plants, the quality of the planting material is important for the successful application of the Vetiver System (VS). This requires nurseries capable of producing large quantities of high quality, low cost plant materials. The exclusive use of only sterile vetiver cultivars [C. zizanioides] will prevent weedy vetiver from becoming established in a new environment and there are many users applying the technology for different purposes. We know that most users, once using it correctly, are avid fans of the technology. Vetiver can survive very cold winter, but dies when the crown is frozen in the ground. In very cold, frosted or under snow cover the outside plants of the thick sward protect the interior part, which remains green and actively treating effluent. Vetiver will survive very hot fires and will recover quickly to continue being an effective erosion barrier and slope stabilizer.

CONCLUSION

Vetiver has traditionally been used as medicinal and aromatic plants in many countries, especially in Asia. Recently it has received widespread recognition as being an ideal plant for soil and water conservation as well as environmental protection. This, however, has met with difficulty in promoting vetiver grown as hedgerows for soil and water conservation since the farmers complain that they do not obtain any direct benefit (i.e. cash return) from planting vetiver. However, it is argued that the indirect benefits the farmers could obtain are enormous. It ends with the discussion on the main objective of planting vetiver, environmental implication, socio-economic aspects, and industrial potentials. As a campaign to go 'back to nature' is everywhere, the utilization of vetiver as a medicinal plant to produce pharmaceutical products on a commercial scale has great potential for development. A new concept, that of growing vetiver as an income generating plant, has recently been launched by the Royal Project Foundation of Thailand. This approach in interesting since vetiver provides a very good income to the farmers if grown specifically for its roots.

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	Dhirendra Kumar, Final year student of M.Sc. in Environmental Science, School of Energy, Environment and Earth Science, Central University of Kerala, Tejaswani Hills, Periya (PO), Kasaragod (DT), Kerala-671316, join and work as Intern at EMG, CSIR – CIMFR, Dhanbad, Jharkhand, India in the year 2016 and publishing his first review paper on his scientific project work taken for the partial fulfillment of M.Sc. degree course.
	Dr. Kumar Nikhil, Ph.D. in Env.Sc. &Engg., Principal Scientist at Environmental Management Group, CSIR- Central Institute of Mining and Fuel Research (CIMFR), Barwa Road, Dhanbad - 826 015, Jharkhand, India as gained more than 30 years of research experience involved in more than 60 projects in different capacity. More than 135 scientific publications on his name. Guided more than 60 students of B.Sc., M.Sc., B.Tech. &M.Tech, Ph.D. students in their project and research works.