

EXECUTIVE SUMMARY*

Vetiver (*Vetiveria zizanioides* (Linn.) Nash.), a native grass of India, has been extensively used for land protection and as an essential oil in the perfumery industry. Systematic efforts to develop applications of vetiver grass technology (VGT) to mitigate soil erosion and water conservation were initiated in India in 1986 through several World Bank-funded projects in low rainfall areas. Research conducted over the last 10 years demonstrates that VGT is one of the most effective and natural low-cost methods of environmental protection. Lately, in view of its eco-friendly nature, vetiver grass has found new uses for construction purposes (bioengineering) and remediation of contaminated sites (phyto-remediation). The Second International Conference on Vetiver: Vetiver and the Environment (ICV-2) was organized in Thailand from 18 to 22 January 2000 by the Office of the Royal Development Projects Board, Bangkok. The conference was attended by 325 participants from 31 countries. Besides scientific deliberations, one of the most important attractions of the conference was the technical tour to vetiver project sites. In all, 10 plenary lectures were followed by panel discussion on experience in putting together countrywide vetiver programs, policy issues, expectations and results (6 presentations); vetiver and natural disaster (4 presentations); and reports on regional and national networks (9 presentations). The conference theme was divided into three concurrent sessions: (i) soil and water attributes (16 papers), (ii) basic research and general studies (14 papers), (iii) other topics (16 papers) covering seven broad topics, and a poster session (34 posters). The concluding session had projections about the theme of the next conference and recommendations.

In his opening plenary lecture, *Richard Grimshaw* (The Vetiver Network, United States) emphasized that currently 138 countries know about VGT, 100 are using it in one form or another and over 800 NGOs and an equal number of government agents are associated with its use. In 1986, VGT was solely applied as an erosion control measure; in the year 2000 it was being used for highway stabilization, mine land rehabilitation, river, canal, drainage bank and seashore stabilization, windbreaks, pollution control mitigation associated with municipal trash dumps, and housing construction site stabilization. There is an increasing involvement of the private sector in the establishment of VGT enterprises that serve the engineering sector.

Diti Hengchaovanich (APT Consult Co, Thailand) highlighted the unique characteristics of vetiver vis-à-vis its utility as bioengineering option for environmental conservation and protection. He further supplemented His Majesty the King of Thailand's remark that "vetiver is a living wall" and illustrated its unique properties with respect to tensile strength and the growth pattern of its roots. He provided evidence that the grass is able to form a dense hedge within three to four months, resulting in the reduction of rainfall runoff velocity and thus of sediment. Its vigorous, massive and dense subterranean root system reaches vertically from 2 to 3 m in depth, facilitating soil binding and aeration. Further, in view of the growing interest in plants for phyto-mining and phyto-remediation/rehabilitation of contaminated soil and wetlands, vetiver is used to rehabilitate gold, platinum, coal and other mines. Realizing the significance of VGT for the rehabilitation of landfills, *Diti Hengchaovanich* mentioned that a test section has been established for planting vetiver at a major landfill in Kamphaeng Saen, 90 km northwest of Bangkok, with 5 000 tons of garbage. It has been observed that vetiver plants were able to survive fairly well, despite the presence of leachate and high toxicity.

Paul N.V. Truong (Queensland Department of Natural Resources, Australia) furnished scientific data and field observations relating to high tolerance levels of vetiver grass to adverse soil conditions, heavy metal toxicity and agrochemicals. The specific data provided have underpinned that VGT is an effective, low-tech and low-cost method for mine rehabilitation and for offsite pollution control by trapping pesticides, herbicides and nutrients in runoff water from agricultural lands, and that vetiver is highly suitable as a wetland species, as it is extremely tolerant to high levels of agrochemicals under wetland conditions. All of this has positive implications for the protection of the terrestrial, aquatic, aerial and social environment and for the mitigation of natural disasters.

* Adapted from the Conference Report by Dr. Umesh C. Lavania, Deputy Director, Central Institute of Medicinal and Aromatic Plants, Lucknow, India. (Source: *Curr. Sci.* 78: 944-946, 2000)

Songkiert Tansamrit (Petroleum Authority of Thailand) provided the necessary design/construction and planting guidelines regarding the use of a vetiver grass system for effective control of soil erosion and for slope stabilization along the gas pipeline in the Yadana gas pipeline project.

Hong Cheng (Ministry of Water Conservancy, China) provided experimental evidence for the application of line-planted vetiver to fix sand in subtropical deserts, where sand dunes dislodge the desert soil.

James Smyle (World Bank, Costa Rica) provided a natural resource perspective on the prospects for VGT in disaster mitigation and vulnerability reduction.

W.S. Shu (Zhongshan University, China), *Liyu Xu* (China Vetiver Network) and several others recalled their country experiences regarding the use of VGT in soil erosion and sediment control on sloping farmlands and floodplains, rehabilitation of saline and acidic sulphate soils, landfill and contaminated lands, purification of polluted water, control of algae growth in rivers and dams, removal of heavy metals, trapping of agrochemicals and nutrients, effluent disposal, feedlots, piggeries and other intensive livestock industries, onsite and offsite pollution control from mining waste, mitigation of natural disasters such as typhoons, landslides, floods, steep-slope infrastructure, etc.

Due to the prolonged drought caused by El Niño, there is little work left for rural farming communities in several countries. However, the need of vetiver planting material to support various infrastructure projects has provided employment opportunities to the affected rural communities. *Mary Noah S.J. Manarang* (Vetiver Farms, Inc., Philippines) said that advocacy for VGT and its commercial aspects attracted her to launch a vetiver nursery and propagation program and thus increased employment in villages. She said that VGT was being extensively used in several countries of Southeast Asia, more particularly Thailand, Malaysia, China and the Philippines, where several private entrepreneurs have taken up the job of vetiver propagation and supply.

Pisoot Vijarnsorn (Land Development Department, Thailand) opined that after selection of an elite genotype suitable for the specific purpose, a propagation program needs to be developed quickly to obtain thousands of seedlings to plant. An extensive program of propagation was initiated in Thailand in 1993 and by the end of 1999 made some 10 million plants. He said that for faster propagation, the elite source plants are first grown in nursery and then propagated through tissue culture to establish multiplication nurseries.

R.P. Adams (Baylor University, United States) and *Pattana Srifah* (Kasetsart University, Thailand), through their independent work on genome analysis based on RAPD and SSCP DNA techniques, demonstrated that there is tremendous genetic diversity among vetiver species, but this is mainly confined to South Asia. Almost all vetiver grown outside the region represents a single genetic stock.

U.C. Lavania (Central Institute for Medicinal and Aromatic Plants, India) attempted to further classify the vetiver species of South Asia by origin and dispersion angle. Based on analyses of morpho-taxonomic and cytotoxic observations, he suggested that peninsular India was most likely the primary centre of origin of vetiver, from where vetiver may have dispersed in different directions: northward in the Indian subcontinent and to Southeast Asia. *Seshu Lavania* (Lucknow University, India) presented a case study on nematode-induced root-knot infestation in this otherwise very hardy plant.

Through an experimental study on externally applied heavy metals (Mn, Zn, Cu, Cd and Pb) to elucidate uptake potential by vetiver grass, *Nualchavee Roongtanakiat* (Kasetsart University, Thailand) suggested that vetiver grass has vast potential to uptake and tolerate toxicity to heavy metals, but to further enhance the efficiency of heavy metal uptake it is desirable to have regular trimming of the upper-ground biomass. It was further mentioned that mature vetiver grass shows better absorption of heavy metals than the young seedlings.

Md. Shariff (US Army Corps of Engineers, United States) highlighted the significance of vetiver in combating severe land disturbance and soil erosion/sedimentation problems encountered in US Army training missions. He emphasized that to minimize the damage caused by tank movement, planting of vetiver could be an ideal choice.

The exhibition of *Vetiver Technology and Products* displayed the works of 24 agencies in Thailand involved in vetiver research and development. The display had live materials showing the use of vetiver in soil deterioration/erosion prevention and stabilization of pond ridges; vetiver multiplication and vetiver planting patterns; and vetiver usefulness in different agricultural/cropping systems, forest and orchards management and pollution control from pesticide leaching/disaster prevention in critical areas, breakage of hard-pan soils, planting of vetiver hedgerows along slide slopes; propagation using inflorescence and axillary's bud culture or using dibbling tubes and samples of vetiver ecotypes. A mini live model depicting the use of VGT for soil and water conservation in different areas (slope, agricultural land, edge of farm pond, reservoir, canal, and small check dam) was also displayed.

A one-day technical tour to major project sites provided an on-the-spot demonstration of VGT in the rehabilitation of degraded and hard-pan soils and in industrial uses of vetiver products. Vetiver grass planted along the ditches under broad-bed-based vegetable cultivation and fruit trees helps to prevent soil erosion on the broad-bed from collapsing, and to conserve soil moisture. This has facilitated re-vegetation of once barren land just in a period of 10 years. Planting of vetiver rows at vertical intervals of 1 m along the little slopes, 2 m for areas with moderate slopes and 4 m in mountainous areas has helped maintain topsoil and retain moisture. Within five years this has improved ecological conditions and restored green cover. The program activities include: (i) forest rehabilitation using the vetiver system for hard-pan soil profiles, (ii) display of the use of vetiver for preserving soil erosion, maintaining moisture in the forest rehabilitation area and strengthening and preventing the collapse of a check dam, (iii) vetiver multiplication and nursery, (iv) product development from vetiver leaves from cottage-type activities, from woven decorative and household articles to hi-tech products such as vetiver boards, pots, compressed partition walls, floor tiles and interior decoration items. The orchards of a farmer and volunteer "Soil Doctor" display the strength and potential of VGT in maintaining soil fertility in inundated areas. Ring planting of vetiver around trees brings about reduction in silt inflow and also facilitates maintenance of soil aeration on account of their massive root system, thus mitigating the adverse effects of water logging.

Although, no formal recommendations were made during the conference, but the following lines of future action were apparent. (i) The vetiver natural system should be preferable over high-tech mechanical operations for conservation and recharging of water resources, (ii) soil, water and leachate detoxification potential of vetiver need to be further explored for environmental remediation and rehabilitation, (iii) in order to sustain VGT efforts, it is necessary to further explore commercial and industrial utilisation of vetiver products. Accordingly, highlighting the significance of vetiver in detoxification, conservation and recharging of water resources, *Richard Grimshaw* of The Vetiver Network stressed the need to intensify efforts in this direction, and suggested "Vetiver and water" to be the focal theme for the next international conference in 2004.