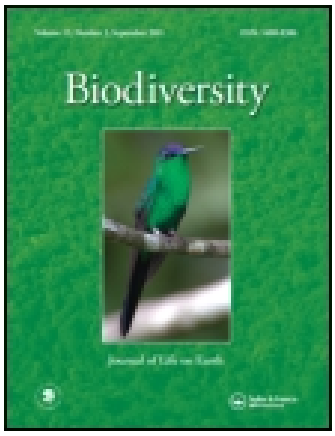

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BLOSSOMING TREASURES OF BIODIVERSITY

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BLOSSOMING TREASURES OF BIODIVERSITY: 31. *Vetiver Grass*—poverty alleviation by habitat restoration

Ernest Small

There are millions of species on Earth, almost all restricted to particular habitats. By usurping or altering their natural habitats, we humans have eliminated or endangered an alarming number of them. Many believe that the key solution to the biodiversity crisis is to adopt "sustainable" systems of resource usage that will curtail the elimination of remaining habitats and their species. However, even if human population growth ceases, numerous people currently in poverty not unreasonably want to increase their use of world resources, which seems likely to greatly exacerbate the problem. This contribution features an extraordinary plant that addresses three interrelated problems: increasing sustainability, alleviating poverty, and conserving the planet's habitats and biodiversity.

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Chrysopogon zizaniodes (previously known as *Vetiveria zizaniodes*) has been referred to as the "Wonder Grass". As detailed below, the plant is indeed wonderful. (1) It is extraordinary tolerant of highly adverse soil and climate conditions found in tropical and subtropical areas of the world where poverty is frequent. (2) The species has exceptional utilitarian characteristics, well suited to simple technologies that are easily adopted in poverty-affected rural and agrarian cultures. (3) Vetiver-based applications are self-help in nature ("a hand up, not a handout"), of direct benefit principally to poor people, providing them with new skills, employment, income, and the ability to produce their own crops and a range of goods for personal consumption and sale. (4) Vetiver provides cheap and effective ways of preventing habitat damage by erosion, and of rehabilitating damaged habitats. Remarkably, the use of Vetiver promotes (a) sustainable agriculture, (b) sustainable commerce, (c) poverty alleviation, and (d) habitat and biodiversity protection.

While the use of Vetiver Grass for various purposes is ancient, the present widespread application of "bioengineering" technologies applied to landscapes to solve problems of environmental degradation developed in the latter half of the 20th century, the result of initiatives by two World Bank agriculturists, John Greenfield and Richard Grimshaw. They subsequently, along with others, have championed Vetiver Grass usage throughout the world. Detailed information about the impressive international development of Vetiver-based initiatives and accomplishments will be found in the literature cited in this article, and especially at the website of The Vetiver Network International, also cited below.

THE PLANT

Vetiver Grass is a robust, perennial, densely tufted grass growing up to 3 m (10 feet) high, but typically about half this height. The leaves are narrow (usually 3-13 mm or 0.1-0.5 inch wide), and as long as 140 cm (4.6 feet), but typically about 75 cm (30 inches) long. The massive, fibrous root system is the key to Vetiver's amazing soil and water conservation properties. The roots can grow down over 3 m (about 10 feet) in the first year, and have been recorded at depths of 5 m (16 feet), although normally most of the root mass is in the top 30 cm (1 foot). The roots tend to grow straight down, with very limited lateral growth. However, grown close to each other, roots intertwine, forming a sod that is so tight it can block the movement of soil. The roots can develop very quickly, sometimes as much as 60 cm (2 feet) in 3 weeks. The stems can also develop rapidly—often growing to a height of 2 m (6.6 feet) in a few months. Vetiver has very short rhizomes (laterally spreading, underground stems), but its ability to spread by rhizomes is very limited.

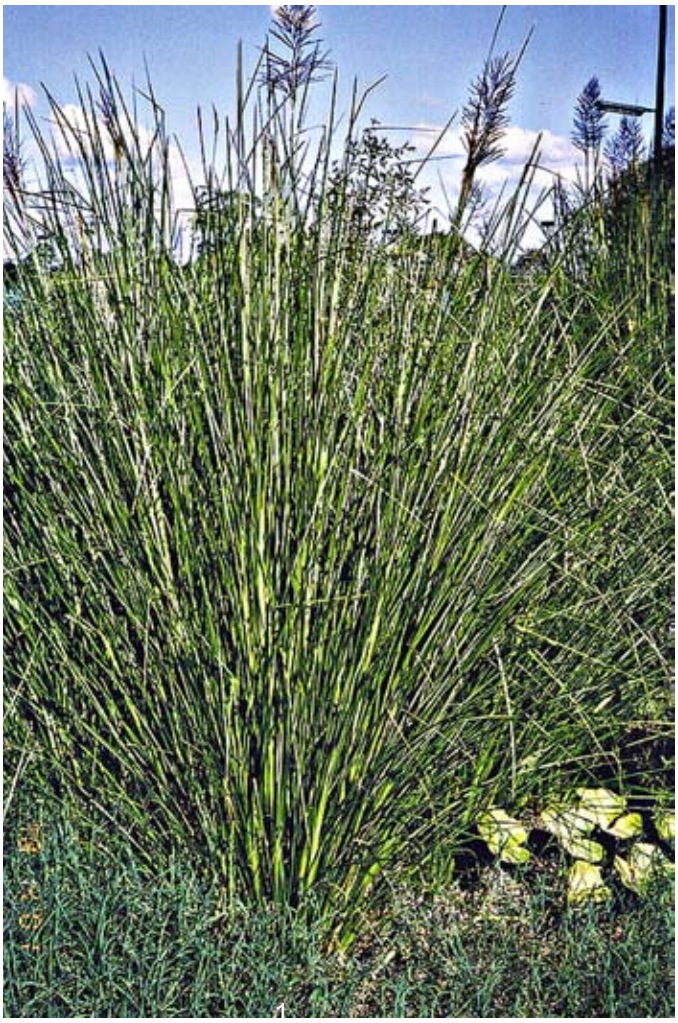


Figure 1. A flowering but sterile clump of plants of a cultivar of Vetiver Grass, *Chrysopogon zizanioides* 'Monto Vetiver', in Queensland Australia. (Photographer: *Paul Truong*).

Figure 2. Enormous root system of a clump of Veviter Grass grown in China. The massive volume of fibrous roots accounts for the amazing soil-stabilizing properties of the plant, as well as its ability to retain nutrients and water in the soil. (Photographer: *Xia Hanping*).

New shoots develop from the base of the plant. Wild plants, but often not sterile forms of cultivated Vetiver Grass, produce flowering axes (panicles) 15-40 cm (6-16 inches) long, the floral display appearing to be brown or purple.

Two fundamental classes of Veviter Grass have been distinguished. So-called "North India Vetiver" includes wild plants that are fertile (producing abundant seed); these are infrequently cultivated. By contrast, "South India Vetiver" or "Ganges Vetiver" plants are cultivated, rarely flower or produce seeds, and have been selected over past centuries for various applications. The two classes of plant are known to differ in chemical composition of their essential oil. It is thought that the mostly sterile type of plant represents a domesticated form of the wild, fertile type. One particular race of the sterile type, christened "Sunshine" (named for a small town in Louisiana), has been shown by DNA analysis to be extremely widely distributed and very uniform genetically. It is well known that crops lacking genetic variability are in danger of being decimated by evolving races of disease organisms, and there is some concern that Sunshine is susceptible to this potential problem.

GEOGRAPHY AND ECOLOGY

Vetiver Grass originated in Southwest and south central Asia, and the domesticated kind of plant was selected there. The original area of distribution of the wild plant (North India Vetiver) is unclear; it certainly includes the region from Pakistan to Bangladesh, and may extend as far east as Vietnam. The domesticated kind (South India Vetiver) has become distributed in many tropical countries, and is the primary kind of plant encountered outside of southern Asia, including eastern Asia, tropical Africa, Polynesia, and South America. Vetiver Grass has been used in well over 100 nations for one or more of the applications described in this article, and there is about half a century of research documenting its value for soil and water conservation in numerous countries.

The species grows well in tropical and sub-tropical regions, particularly under hot and humid conditions. The plants are found on a wide range of soils, including saline, sandy, and waterlogged soils, but prefer somewhat heavy to medium textured soils that are moderately to quite fertile. Vetiver is capable of surviving on soils as acidic as pH 3, and as alkaline as pH 10. While the plants can tolerate very dry conditions, they thrive in high rainfall, humid climates, and in locations with a high water table. Indeed, it appears that Vetiver is naturally a plant of wet or periodically inundated areas, including stream banks, flood plains, and freshwater swamps (*zizaniodes* in the scientific name means "by the riverside"). The roots are spongy, the air spaces facilitating access to oxygen by the cells of the root when it is under water. The species is very resistant to most diseases and pests, as well as to fire and heavy grazing. Vetiver Grass requires an open habitat, and is intolerant of heavy shade. While it withstands freezing temperatures for a period, it does not grow well in temperate climates because of its natural adaptation to hot climates. The thick mats developed by Vetiver Grass growing as a wild, semi-aquatic plant provide a habitat for many species. Some farmers once uprooted the plants in fear of insects, rodents, and snakes which are resident in the grass, but increasingly the economic value of the plant is contributing to respect for it.

USES

LAND AND WATER STABILIZATION, DISASTER MITIGATION, AND HABITAT REHABILITATION

The loss of an estimated 20 billion tons of topsoil every year (the equivalent of losing about 6 million hectares or 15 million acres of arable land) is one of the critical problems facing the modern world, but this is not a new challenge. Some past societies are thought to have unintentionally committed "ecocide" (ecological suicide) by damaging their environment and consequently their resource base. Topsoil loss is hypothesized to have contributed to the demise of civilizations in the past, for example the Maya of Central America. Tropical areas are especially vulnerable to erosion, torrential downpours washing away vast amounts of topsoil, and winds also blowing away this indispensable resource. Equally distressing, the soil accumulates in waterways and the ocean, where it is often very damaging to aquatic ecosystems upon which many people depend. Many poor countries are dangerously close to economic collapse partly because of the destruction of their environment, which is in desperate need of rehabilitation.

While Vetiver Grass is a multi-purpose plant, it has primarily been used as a "living dam" to prevent soil erosion by stabilizing steeply sloping lands with hedges planted across the contours of the slope. Initially Vetiver was used to protect farmlands from erosion and to conserve water, thereby promoting growth of crops. More recently, Vetiver is also being used on man-made slopes, such as those associated with roadsides, railway embankments, dams, drainage ditches, and spillways. A hedge of Vetiver across a slope serves to slow and spread out runoff water, not only reducing or eliminating erosion, but also allowing time for the water to infiltrate the soil. Moreover, the slowing down of the water flow causes deposition of sediment on the upper side of the hedge, resulting in a natural terrace of rich soil which can serve to grow crops. Several characteristics of Vetiver make it very much more suitable for this application than almost any other plant species. The rapidly growing, stiff stems produce a uniformly dense hedge, providing high resistance to water flow. The extensive and deep roots bind soil. Moreover, the roots break up the soil, including compacts layers (hard pans), permitting excellent infiltration and retention of water. The ability to grow under

Figures 3- 4. Use of new plantings of Vetiver Grass to stabilize slopes bordering a new railway in northern Madagascar. 3, Low-lying portion; 4, Elevated portion. (Photographer: *Yoann Coppin*).
Figures 5-6. Use of Vetiver Grass to stabilize land bordering water. 5, Vetiver Grass stabilizing a river bank slope in Thailand. (Photographer: *Dick Grimshaw*); 6, A worker trimming a Vetiver Grass hedge established for beach stabilization in India. (Photographer: *P. Haridas*).
Figures 7- 8. Many towns in West Africa have huge urban gully problems. The problem shown at the left was repaired through community labour and vetiver, as shown at the right. Vetiver specialist Alain Ndona managed this initiative. (Photographs courtesy of *A. Ndona* and *D. Grimshaw*).

Figure 9. Use of Vetiver Grass to stabilize sand dunes in Madagascar. This dune was a mass of sand being moved by strong and continuous winds until Vetiver Grass was applied. Millions of plants have been grown by small local farmers and their families for stabilizing some critical and large sand dunes, providing critical income. (Photographer: *Roley Noffke*).
Figures 10-11. Use of Vetiver Grass as an insect repellent. 10, An Ethiopian grain storage container lined with soil and Vetiver leaves. The anti-pest properties of Vetiver inhibit insect damage to the grain. (Photographer: *Dick Grimshaw*); 11, A commercially marketed bundle of Vetiver Grass roots. (Photographer: *Brenda Brookes*). Such aromatic preparations are used like moth balls to protect clothing and linens stored in closets and drawers from being eaten by insects, and like sachets to impart a pleasant aroma.

both very dry and very wet conditions contributes to a very long hedge life. The lack of lateral growth keeps the plants growing in a very narrow row, minimizing competition with adjacent planted crops. The "crown" of the plant is between the roots and stems and occurs just under ground level. Both the stems and roots grow from the crown, making it the most important part of the plant. As sediment accumulates against the upper side of Vetiver planted on a slope, the crown rises to compensate. Without this feature, the crown could be buried too deeply to produce stems.

Because Vetiver can grow as a semi-aquatic, it is also useful for various preventative or remedial applications related to streams and ponds. Planted near water, Vetiver can not only reduce the direct loss of valuable soil from ground level, and the additional leaching away of valuable nutrients by water movement within the soil, but also reduce consequent siltation of wetlands and streams, thereby promoting aquatic habitat conservation. In the island of Vanatu in the South Pacific,Vetiver Grass has even benefited coral, the result of Vetiver hedges preventing sediment from reaching the sea and destroying coastal coral reefs and fisheries. Vetiver has also proven useful for trapping sediments on flood plains. The species is considered especially useful for reducing erosion during flash floods, such as often occur in monsoon areas, the deep roots preventing the plants from being washed away.

"Phytoremediation" is the use of plants to eliminate, reduce, or neutralize high levels of soil or water contaminants. Absorption of contaminants can be particularly desirable in pollution control and water purification, for example in the case of effluent from pig farms, abattoirs, feedlots, and sewage plants. Similarly phytoremediation is often required for water that has been made toxic by heavy metals or pesticide runoff, or has been eutrophied (enriched) with excessive nutrients like nitrogen and phosphorus that could cause excessive algal growth and degrade natural waterways. Vetiver is quite efficient at accumulating some heavy metals in water—zinc and lead levels can rise in the roots up to 1% of their weight—and it may be commercially feasible to extract and market the metal from the plants. Vetiver is also useful for rehabilitating lands that have been contaminated by mine tailings, other kinds of chemical deposits, and salinization, because of its very high tolerance to these situations. Very few plants grow on contaminated soils, and Vetiver Grass acts as a "nurse plant", improving the soil so other plants can grow.

PERFUME AND INSECT REPELLENT

Vetiver has been used for centuries as a source of essential oil known as "oil of veviter", used in synthesizing high-class perfumes. The aroma has been compared to sandalwood. The oil is also added to soaps, lotions and other cosmetics, deodorants, and tobacco, and is used in aromatherapy. In some cultures (especially in India), the oil is used to flavour foods, including beverages, chewing gum, ice cream, and sherbet. The oil is also used in traditional Asian medicine, for flatulence, colic, vomiting, and a wide range of other conditions. The annual production of this oil is about 2500 metric tonnes. Haiti and Indonesia (mostly the island of Java) account for about 80% of production, with other areas of cultivation found in Angola, Brazil, China, Guatemala, India, and the Reunion Islands. The name "Vetiver" is based on a Tamil word meaning "root that is dug up",

and indeed the roots need to be dug up. Most of the oil is in the smaller roots, which are difficult to harvest if the soil is hard to work. Plants cultivated for their roots are usually grown in sandy loam soil to facilitate excavation. After extraction of the oil from Vetiver roots, the spent material can be used as raw cellulosic material for production of cardboard and paper.

In India, the roots are often simply layered among stored clothes, both to repel insects and to impart a pleasant smell. The pleasant-smelling roots are often incorporated in sachets (small, breathable containers of fragrant powder or dried herbs, especially used for scenting clothing and the like in dresser-drawers, closets, etc.) and potpourri (jars of fragrant, dried plant material used for scenting the air). The roots are also placed around food to discourage insects.

HANDICRAFTS

Modern technology produces so many consumer products for people in rich nations that it is easy to forget the importance of goods produced from simple raw materials by craftspeople. Cane and bamboo are still the foundation of numerous products in tropical regions. In recent decades, Vetiver has similarly become the basis of extensive cottage industries. Veviter handicrafts production has recently been established in many countries specifically for poverty alleviation. The plants are now extensively used to make common articles, especially by wickerwork involving interlacing of the leaves. The leaves have also been used to make a variety of practical household objects, such as brooms, chairs, curtains, incense sticks, lamp shades, and mats, as well as more personal goods including bags, baskets, belts, footwear, hand fans, hats, and decorative objects such as animal figurines and dolls. Vetiver roots are also occasionally used in making many of the handicraft items usually prepared from leaves, as well as some unique objects, such as fragrant clothes hangers. Vetiver handicraft products are an important source of supplementary income in some rural areas, especially for women. The products are particularly significant in Africa, China, India, Thailand, and Venezuela. In many places where Vetiver has been introduced, international aid groups or government instructors hold workshop training sessions in villages. Many Vetiver handicrafts reveal stunning artisanship, and are often marketed as upscale items.

FORAGE

Vetiver Grass has limited palatability and is normally ignored by livestock. However, under good cultivation the younger leaves have a protein content of 7 to 12%, and harvested younger leaves can be fed to some classes of livestock (including Goat, Sheep, Brahman Cattle and Swamp Buffalo), and even fish, but are preferably mixed with more nutritious forages. Although Vetiver is inferior to most cultivated grass forages, it can be grown on very poor lands with minimal care. Vetiver Grass is grown to some extent as forage on marginal lands by small scale dairy and livestock farmers.

ROOFING AND CONSTRUCTION

The foliage of Vetiver have been used as a long lasting thatch in various countries, including Fiji, New Caledonia, Senegal, Ethiopia, and Mexico. The leaves have a natural wax coating that tends to repel rain, and their insect-repelling qualities make huts more livable. While roof thatch has been the primary construction use of Vetiver, there are indications that it could be used more widely. Vetiver was once used in building the sides as well as the roofs of simple huts, often as a fiber-strengthening component of clay bricks or mud. Straw-based concrete blocks, straw bales, and straw-based fibreboard represent possible future methods of housing construction that could alleviate poverty, and Vetiver seems suitable for such needs.

Figures 12-13. Use of Vetiver Grass in handicrafts. 12, A display in Thailand; 13, Thai craftspeople, who have developed exceptional skill in the production of Vetiver products. Preparation of Veviter handicrafts is a significant cottage industry for poverty alleviation in several areas of the world. (Photographer: *Criss Juliard*).

MINOR USES

As noted above, Vetiver oil is used in traditional Asian medicine. So are decoctions (boiled preparations) of the leaves, applied externally for problems like rheumatism, lumbago, and sprains. Preparations of the roots are also used to treat numerous conditions.

Vetiver Grass is extremely competitive, often growing so densely that it crowds out weeds. Indeed, some tropical Sugar Cane and Tobacco farmers have deliberately planted a border of Vetiver Grass around their crop to block the entry of invasive weedy grasses, like Bermuda Grass – *Cynodon dactylon*, and Kikuyu Grass – *Pennisetum clandestinum*, that spread by creeping rhizomes (underground stems).

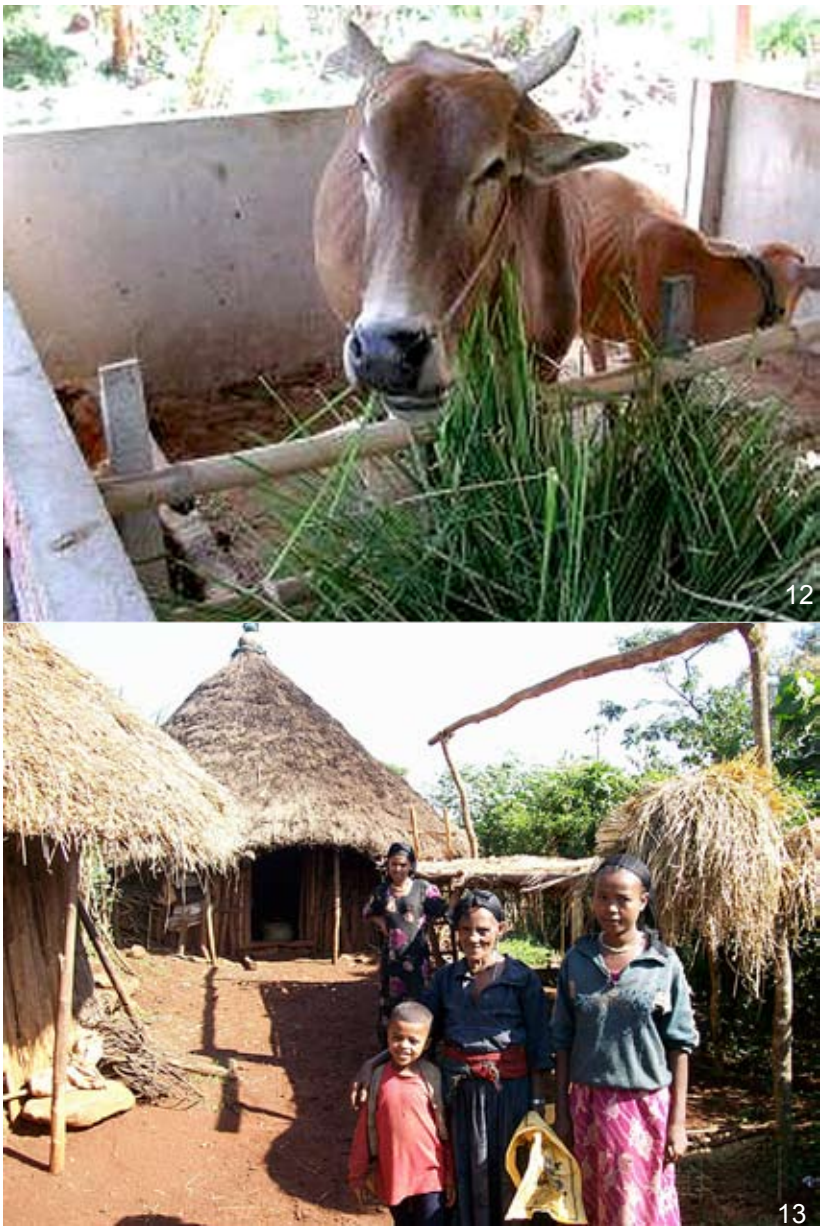
Mulching is extremely important in hot, arid, tropical countries, for vegetable plots and fruit orchards. Mulch provides shade, decreasing the temperature and conserving moisture. In areas with high and intensive rainfall, mulch can serve to absorb water and keep soil from washing away. Mulch also keeps weeds under control. Of course, numerous plant materials can serve as mulch, but Vetiver leaves are especially useful because they are durable and long lasting, and their insect-repelling property discourages pests.

In many African countries, Vetiver Grass is used to stuff mattresses, because of its insect repelling and long-lasting qualities. For the same reasons, as well as for its good absorptive value, Vetiver Grass also is used for livestock bedding.

CONSERVATION CONCERNS

The principal concern that environmentalists have expressed regarding Vetiver Grass is that it may have potential for invasiveness. A grass that is so extraordinarily tolerant of a very wide range of environmental conditions, and is naturally a pioneering species, would seem to be potentially invasive. The extent to which fertile forms of Vetiver Grass are invasive is unclear, but the Vetiver industry has wisely insisted that only sterile forms be utilized for various applications. Given that the plants do not spread vegetatively, use of non-seeding forms effectively prevents Vetiver from posing an invasive threat.

Although the sterile (South Indian Vetiver) plant is the form primarily used to produce oil of vetiver, the wild (North India Vetiver) type is considered to have especially valuable oil; indeed, the wild plants are being overharvested in northern India. It has been proposed that because the wild plants are known to grow well on a wide variety of "marginal" lands such as salt-affected or water-logged soils, they could be cultivated on such areas. While this proposal seems legitimate where Vetiver is indigenous, this is not an attractive idea for non-indigenous areas from the point of view of biodiversity, because the plants could be potentially invasive. Moreover, so-called "marginal lands" are often just where many rare species are found.



Figures 14-15. 14, Use of Vetiver Grass as forage. Vetiver Grass cut at a young stage of growth provides good forage, as indicated by this stall-fed animal; 15, Use of Vetiver Grass as roofing. These huts in the Mettu District of Ethiopia have thatched roofs made with Vetiver Grass, which have proven to last at least 11 years. (Photographer: *Dick Grimshaw*).

LINKING VETIVER-BASED SOCIAL AID WITH HABITAT AND BIODIVERSITY PROTECTION

"Green politics" refers to a global political movement that generally advocates policies that proponents believe promote *both* societal and environmental well-being. Developmental aid from rich nations to areas of the world requiring poverty alleviation is admirable, but is especially desirable when that aid promotes environmental protection and consequently the vital habitats of the world's biodiversity. Vetiver Grass is naturally adapted to climate-stressful tropical and subtropical areas of the world, where poverty is most acute, and coincidentally where biodiversity loss is also most severe. The Vetiver Network International, a Non Governmental Organization sponsored by the World Bank and other high-profile backers, has for several decades achieved remarkable success in promoting the use of Vetiver Grass in a manner that achieves both environmental protection and poverty alleviation (see the website noted below for details). Impoverished people, typically in rural or village settings, are taught simple techniques based on transplanting nursery-grown Vetiver Grass, to achieve soil and water conservation and landscape rehabilitation in their local areas. The people benefit by gaining income from propagating Vetiver and improving the productivity and livability of their local environment; and local biodiversity benefits by the saving of habitats from degradation by land erosion and increasing drought.

VETIVER IN SUPPORT OF SMALL SCALE FARMING: GOOD FOR THE ENVIRONMENT AND BIODIVERSITY

Most plant-based food on the planet is now produced as monocultures, i.e. as single crop species grown on an area to the total exclusion of all other plant species. Almost all such crops require considerable "agricultural inputs"—one or more of water (irrigation), biocides (herbicides, pesticides, fungicides, bactericides), and fertilizer; moreover, mechanized tilling of the soil, planting, and harvesting additionally require the input of fuel. These activities result in chemical pollution of soil, water, and the atmosphere, and displacement or destruction of native animals, plants, and soil organisms. The huge efficiency of monocultural

production has enabled the planet to accommodate its huge population approaching 7 billion people, and indeed without monocultures there would be widespread famine and death. A high-output of food is apparently only possible with a high input of chemicals, water, and energy, which inevitably results in environmental problems, although it is possible to alleviate the damage by utilizing a variety of ecologically-based farming practices (see, for example, special issue of *Biodiversity* Vol. 9 (1&2) published in 2008 - *Biodiversity, Food and Agriculture*).

While industrial monocultures and factory farming are now indispensable, there are sound social and environmental reasons to support small-scale farms. "Agrarianism" is a movement advocating a rural and semi-rural way of life, both as a means of achieving personal satisfaction and coexisting in a sustainable fashion with the environment. Small, mixed farms are almost always a relatively friendly environment for wild plants and animals, providing different habitats among the different crops that support animal species. The continuing demise of the small family farm and the growth of huge corporate farms is therefore a growing concern for the environment. In much of the Third World, small "subsistence" farms are still the norm. While subsistence agriculture is very much less efficient than factory farming, it is much more compatible with the environment. In tropical and subtropical countries, which have many more species than found in temperate regions, subsistence and small-scale farms assist in the survival of vanishing biodiversity, a key issue facing the world. A related matter is the supply of "land races" (localized breeding selections) of many useful plants that are maintained on small farms, many of which would disappear with the elimination of the farms. Small, rural farms tend to use less, if any, biocides, and make more use of natural fertilizers (especially manure), and they are environmentally beneficial in this respect.

There are two distinct but related trends that are impoverishing farmers in many poor producing nations, and both are related to the increasing size of farms and farming operations and their control by a few. First is the tendency of large corporations or rich individuals to gain control of agricultural production, reducing farmers to hired workers whose income is maintained at minimal levels. Second is the progressive control by corporations of factors essential to production, harvest, transportation, processing, and sale, and accordingly of limiting the wages of workers. These trends are hardly restricted to farmers in poor nations, but given the relatively limited social support systems and the simple fact that most of these nations are agrarian, a far greater proportion of the population has been negatively impacted compared to Western countries. In most poor countries, agriculture employs over half of the population and is responsible for about a third of the Gross Domestic Product. The conflict is most frequently manifested between individual farmers and small cooperatives on the one hand, and semi-monopolistic, often international firms on the other. Once again, the problem is that a few rich and powerful controlling groups often conduct business in ways that severely penalize numerous, poor, weak, rural, small producers, who are sometimes of a particular ethnicity or gender.

Social aid that simply results in the expansion of agricultural or agroforestry monocultures can alleviate poverty, but at the expense of habitats and biodiversity. For example, Oil Palm (*Elaeis guineensis*) is frequently grown in some of the largest plantations on Earth, with plantings often exceeding 20,000 ha (49,000 acres) in size. Unfortunately huge areas of rainforest in tropical Asia are destroyed annually in order to plant even more. Aid that promotes such projects, however well-intentioned, is short-sighted. In the case of Vetiver Grass technology, the landscapes that are rehabilitated are typically not suitable for the establishment of large monocultures. Throughout the tropics, economically marginal subsistence farmers are being displaced from prime agricultural lands, and forced to utilize steep lands. Vetiver technology promotes the welfare of small, rural productive systems, motivates impoverished individuals and groups to achieve economic independence, and very significantly protects the environment, its habitats, and its biodiversity. The promotion of the "Vetiver Grass System" by foreign aid workers and the adoption of the system in over 100 countries bear witness to its undeniable merit.

Grass: a human's best friend

"Every blade of grass has its own angel that bends over it and whispers, 'grow, grow'."
—Talmudic commentary, Midrash Rabbah, Bereishis 10:6

Most people do not realize how critical grasses are for human existence. The grass family includes the cereals (Wheat, Rice, Corn, Barley, Sorghum, etc.) and Sugar Cane, which account for most of the plant food consumed by people. Livestock also mostly eat grasses, so that most meat and milk consumed by humans, and indeed numerous other animal products, are also heavily dependent on grass. Bamboo, the basis of much of the world's construction is still another important example of the grass family, which is by a considerable margin the most important family of flowering plants. Vetiver Grass is now following in the tradition of grass species that provide critical services to humans, but more so than any other grass, appears to also be valuable to numerous other species.

PRIORITIES AND PROSPECTS

Vetiver Grass technologies are increasingly being popularized throughout the world, mostly in regions where the projects serve to alleviate poverty. There seems to be enormous potential for increasing such applications. The recent earthquake disaster in Haiti is a case in point, where the needs for quick, simple, and proven self-help technologies are urgent. The prospect of coupling humanitarian aid with assistance that would rehabilitate habitats is very attractive, and Vetiver technology could play an important role. Vetiver Grass also has some particularly interesting potential applications from the point of view of ecosystem conservation. It is currently under examination as a possible new source of biofuel; renewable biofuels offer a partial solution to the problem of atmospheric pollution caused by burning fossil fuels. Planting deep-rooted plants like Vetiver Grass could also have a significant role in reducing global warming by storing carbon in the soil. It has been estimated that Vetiver Grass plantations can reduce the annual global increase in atmospheric CO_2 by 5%. While Vetiver Grass is currently not suitable for most temperate regions, some selections appear to be relatively tolerant of cold conditions. As global warming and climate change progress, the use and environmental benefits of Vetiver Grass may extend to more northern countries.

BELIEVE IT OR NOT

- In India, screens called "khuschiks" or "khus mats", woven out of Vetiver Grass, are hung over open windows and doors during the hottest part of the

year, and periodically sprinkled with water to keep them moist. Breezes through these wet screens provide a clever, fragrant "air conditioning" to the house.

- Hedges established from cultivated types of Veviter Grass are extremely long-lived —claimed to persist at times for more than 2 centuries. Moreover, the hedges provide permanent demarcation exactly where they are planted, because the plants do not spread. Accordingly, Vetiver hedges are recognized as legal boundary markers in parts of Asia and Africa.
- In China, some farmers grow a wall of Vetiver Grass around dammed areas, not only to prevent erosion into the ponds that have been created, but to confine ducks being raised for food to the area.
- The roots of Vetiver Grass are so strong they have a tensile strength 1/6th of steel. According to a widely circulated report in 2002, a Land Cruiser in the service of the World Wildlife Fund in Madagascar slipped off the road and down a steep bank into a ditch. The vehicle was hooked up to a Vetiver hedge beside the road, and the deep-rooted plants proved so strong that the truck was successfully winched out of the ditch.
- There are three basic classes of land plants, which differ in the way they carry out photosynthesis. Over 90% of the world's flowering plant species are called C_3 plants because the first stable compound formed when carbon dioxide is processed is a three carbon compound, i.e. C_3. C_3 plants are adapted to the relatively cool conditions and normal light levels of temperate regions of the world. About 16,000 species are CAM (Crassulacean Acid Metabolism) plants, which have a type of photosynthesis associated with very limited water use, adapting the plants to arid areas. About 8,000 species are "C_4 plants", so named because the first organic compound incorporating CO_2 is a four carbon compound. Many tropical plants have the C_4 type of photosynthesis, which allows for much faster growth if temperature and light intensity are very high. Vetiver has the C_4 photosynthetic pathway, adapting it to the hot, sunny areas of the world.

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