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Vetiver: A Living Trap

By

Narong Chomchalow

Office of the Royal Development Projects Board
Bangkok, Thailand
April 2015

The Pacific Rim Vetiver Network (PRVN)

Objective: To serve the countries of the Pacific Rim as the center to collect, compile and disseminate information on the use of vetiver in the forms of newsletter, occasional publications, and homepage of the internet.

Member Countries: The following 20 countries, geographical situated in the Pacific Rim, are members of the PRVN: Australia, Brunei, Cambodia, China, Cook Islands, Fiji, Indonesia, Japan, Lao PDR, Malaysia, New Caledonia, New Zealand, Papua New Guinea, Philippines, Samoa, Taiwan, Thailand, Tonga, Vanuatu, and Vietnam.

Scientist Members: Scientists of the member countries of the PRVN who had made prior contact with the RDPB are automatically registered as the PRVN members, which at present amount to about 800. Others who want to join the Network can apply directly to its Secretariat Office. No application form in necessary. Those who are interested to apply just identify themselves with name, current position, place of work, and mailing address, e-mail address, and other information which they deem necessary.

Activities:

Newsletter: An 8 to 16-page quarterly English-language newsletter under the name of VETIVERIM has been issued, starting first number in July 1997. Its circulation is 1,000 copies for each number. It has been sent in bulk to the Country Representatives of the member countries for further distribution to scientists and institutes within the country in order to save postage and other difficulties in international mailing. Starting from No. 63, an e-mail edition has been issued.

Internet Homepage: The PRVN has established its internet homepage which can be seen through: http://prvn.rdpb.go.th. Scientists of the member countries, or from other regions for that matter, are invited to submit information on new research and technologies on vetiver, especially those appropriate to the Pacific Rim countries. Information and pictures are most welcome and can be sent to the PRVN Secretariat by mail, fax, or e-mail (see addresses below).

Publications: It has been the intention of the Secretariat to publish technical bulletins and other documents, as and when opportunity arises. A series of technical bulletins (from one to three bulletins per year) have been launched since April 1998. So far, 21 bulletins have been issued.

The Secretariat

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The Office of the Royal Development Projects Board and the Establishment of PRVN

His Majesty King Bhumibol Adulyadej of Thailand has been dedicated to development work ever since the beginning of his reign in 1946. His Majesty has become familiar with the problems and real conditions of the people through constant visits to every region of the country, often accompanied by Her Majesty Queen Sirikit and other members of the Royal Family. It is during these many Royal visits to the rural areas that His Majesty has realized the need to initiate development projects that would directly benefit the people at the grassroots. Thus, the first Royal Development Project was launched in 1952 followed by numerous projects, which currently reach the total of 4200.

However, the implementation of the Royal Development Projects in the past lacked cohesiveness because each agency carried out the work on its own without coordinating with other concerned agencies. Therefore, in order to serve and implement the Royal initiatives through a consistently integrated system which allows the Royal Development Projects to run efficiently, the Thai government issued a “Regulation of the Office of the Prime Minister” which became effective on 9 September 1981. The Regulation led to the establishment of the Coordinating Committee for Royal Development Projects which later became the Royal Development Projects Board in 1993. The Board has the major task of directing, monitoring and coordinating the operation of government agencies and state enterprises concerning the Royal Development Projects. Moreover, it considers and approves projects, plans and activities as well as expenditures to be used in the operation of the projects. All of these tasks are supported by the Office of the Royal Development Projects Board (ORDPB), the secretariat of the Board.

With agriculture being the backbone occupation in the Thai society, His Majesty the King understood the vital need in preserving natural resources and therefore, initiated the vetiver grass project in Thailand. The project principally aimed to mitigate soil erosion, a distinct aspect of environmental deterioration in Thailand which needs to be managed properly. His Majesty recognized the potential of vetiver grass as a practical and inexpensive yet effective management and conservation tool to address the soil erosion problem. As a result, the Committee on the Development and Promotion of the Utilization of Vetiver (CODPUV) under His Majesty’s Initiative was set up under the administration of the ORDPB in 1992 to look after all the Royally-initiated vetiver projects implemented in various parts of the country. The First International Conference on Vetiver (ICV-1) was co-organized by the Chaipattana Foundation and the Mae Fah Luang Foundation with the collaboration of the World Bank and the FAO. The main purpose was to commemorate the 50th Anniversary Celebrations of His Majesty the King’s Accession the Throne.

Immediately after ICV-1, a proposal was made by Mr. Richard Grimshaw, who was then the President of the Vetiver Network, to establish the Pacific Rim Vetiver Network (PRVN) in Thailand with the principal objective of serving as the center to collect and disseminate information on the use of vetiver grass in the form of newsletters, occasional publications as well as a homepage on the internet. His Majesty the King agreed with the proposal and commissioned the setting up of the PRVN under the supervision of the CODPUV, to be administered by the ORDPB. The PRVN then became active with the establishment of a working team on 6 May 1997.

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Foreword

One of the immediate activities of the Pacific Rim Vetiver Network (PRVN) is to disseminate information on the Vetiver System (VS), especially those techniques that are adaptive to local conditions of developing countries in the Pacific Rim. In this connection, the PRVN Secretariat is publishing a series of technical bulletins (TBs) that provide useful information about the VS to readers who are active members of the PRVN. Since 1998, one to three TBs have been published annually. Altogether, 22 TBs have been published.

The present TB deals with unfamiliar function of vetiver in trapping living and non-living objects. Non-living objects that are trapped by the vetiver hedges are sediment, fertilizer, pesticides, agrochmicals and nutrients, and heavy metals. Living objects that are trapped by the vetiver plant are insects, nematodes, and weed seeds. Through its diverse types which include living trap, trap crop and dead-end trap crop, several benefits are derived. These are purification of wastewater, control of algal growth, pollution reduction, making the soil more fertile, pest control and phytoremediation.

The author wishes to express his sincere thanks to the following persons:

- Prof. Johnnie van den Berg, for reading through the manuscript and providing some pictures.
- Dr. Paul Truong, for reading through the manuscript and providing some pictures.
- Mr. Richard grimshaw, for reading through the manuscript.
- Dr. Pitayakorn Limthong for providing some pictures.
- Mrs. Wilaiwan Wongkasem for providing some pictures.

It is hoped that this technical bulletin will be of some value to the vetiver research scientists and other vetiverites who are interested in the non-conventional function of the vetiver hedges in trapping living and non-living objects carried along by the.runoff from higher areas of the slope and deposited in front of the vetiver hedges while at the same time obtain a several benefits such as water purification, control of algal growth in rivers and dams, pollution reduction, making the soil more fertile, pest control and phytoremediation.

Narong Chomchalow
Coordinator, Pacific Rim Vetiver Network
and the author of this Technical Bulletin

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Abstract

While slowing down and spreading fast incoming overland flow, vetiver hedges have proven to be very effective to filter, or to “trap”, any objects that are being filtered through them. VS, when appropriately applied, can be a very effective and low-cost means of reducing particle-bound nutrients and agrochemicals in runoff water from agricultural lands. Vetiver has unique properties of having living wall and living dam, tolerant to pollutants, and extreme soil and adverse conditions, which make it suitable to perform the function of a living trap, trap crop and even dead-end trap crop. Vetiver hedges can act as a living trap that holds back or catches in other objects, either living (viz. insects, nematodes and weed seeds) or non-living (viz. fertilizers, pesticides, agrochemicals and nutrients, and heavy metals) in natural environment. Trap crop are used when pests of agricultural field are trapped by vetiver hedges planted along with the main cash crop to protect it from a specific pest or several pests by attracting them for feeding, breeding and survival. Protection of cash crop may be achieved by preventing the pest from reaching the crop, or by concentrating the pest in a portion of the field where it can be managed. Dead-end trap crop is similar to the trap crop but it is more attractive to insects, but their offspring cannot survive on them. Several benefits can be derived from vetiver trap, namely purification of wastewater, control of algal growth in rivers and dams, pollution reduction, making the soil more fertile, pest control and phytoremediation.

1. INTRODUCTION

Vetiver grass, with its unique morphological, physiological and ecological characteristics, has a key role in soil and water conservation, environmental protection, bioengineering, phytoremediation, etc. Many new types of utilization of vetiver have been added in recent years. One of these is to use it as a trap that holds back or catches in other objects, living or non-living. Vetiver can perform the function of a “trap crop” that is grown to attract a pest species in order to protect a nearby cash crop. Protection of cash crop may be achieved by preventing the pest from reaching the crop, or by concentrating the pest in a portion of the field where it can be managed, or is highly attractive to insects, but their offspring cannot survive on it.

2. THE VETIVER TRAP

2.1 The Meaning of "Trap"

According to Websters' New World Dictionary, when used as a noun, a trap is "any device for catching animals", or "any strategem or ambush designed to catch or trick unsuspected persons"; when used as a verb, trapped or trapping means "to catch in", "to hold back", "to seal off by a trap", "to furnish with a trap", or "to set a trap"

The traps are non-living things while those which are trapped are all living creatures. However, the word "trap" can be extended to be used for living thing, which performs the function of trapping other objects, be they living or non-living. This is exactly what the author is trying to bring out – vetiver plants grown in a single line along the contour can act as a living trap that holds back or catches in other objects, living or non-living. While slowing down and spreading fast incoming overland flow, vetiver hedges have proven to be very effective to filter, or to "trap", any objects that are being filtered through them.

2.2 Unique Properties of Vetiver as a Trap

Vetiver has unique properties which make it sutitable to perform the function of a trap. These are:

2.2.1 Living Wall: Vetiver plants, with their thick clumps growing close together along the contour of sloping land, act as a living wall to slow down the fast running water from the higher area, and collect debris, sediment and water to stay infront of the vetiver hedge, thereby depositing them there as if they are trapped (Figs. 1-3).

2.2.2 Living Dam: With their deep root system penetrating vertically down to subsoil layer, together with thick and strong clumps, vetiver hedges act as a living dam in collecting everything dispersed alongwith the water runoff. These are then deposited in front of the vetiver hedges. In this way, sediment, fertilizer, weed seed, etc., are all collected there. In addition, such hedge of vetiver with strong root system helps to bind the soil particles to stay in place, not carried away with the current and wind (Fig. 4).

2.2.3 Highly Tolerant to Pollutants: Vetiver is highly tolerant to high concentration of pollutants (Truong, 1999; Roongtanakiat, 2009).

2.2.4 Highly Tolerant to Extreme Soil Conditions: Vetiver has been found to be highly tolerant to extreme soil conditions including heavy metal contamination (Truong and Baker, 1998). In addition, vetiver grass has a very high level of tolerance to extremely adverse conditions, including heavy metal toxicity.

2.2.5 Highly Tolerant to Extreme Adverse Conditions: Vetiver has a very high level of tolerance to extremely adverse conditions, including soil acidity, drought, flood, fire, low and high temperatures, etc.

2.3 How Does the Vetiver Trap Work?

If planted along contours across the slope, the clump of vetiver that stands above the ground will produce tillers, forming a green hedge. This makes it capable of trapping crop residues and silts, which are eroded by runoff and enabling them to naturally form an earth embankment. Since vetiver has a deep thick root system which spreads vertically rather than horizontally, it can efficiently endure harsh conditions. The roots densely bind together like an underground curtain or wall, enabling it to store water and moisture. However, since the root system expands sideway up to only 50 cm, it imposes no obstacle to the nearby plants, and is thus considered an effective measure for soil and water conservation. Vetiver hedgerows maintain soil moisture and soil surface, and at the same time, are suitable for cultivating along with cash crops (Figs. 1 and 3).

2.4 Kinds of Vetiver Traps

Vetiver traps can be divided into three categories, namely: (1) living trap, (2) trap crop, and (3) dead-end trap crop. They are discussed below:

2.4.1 Living Trap: This is the term used for vetiver grass when planted in hedgerows along the contour of a sloping land in natural areas. Such hedges of vetiver plant are able to trap both living and non-living objects carried down the slope by the runoff from higher area.

2.4.2 Trap Crop: The principle of insect control by trap cropping has been known for centuries and is being applied in many traditional farming systems (Hakkanen, 1991). Recent developments in agriculture and ecology have contributed to a renewed interest in trap cropping. It is increasingly being used as a tool in integrated pest management (Shelton and Badenes-Peraez, 2006), as well as in managing insect pest damage. Essentially, trap crops are those that are planted along with the main cash crop to protect it from a specific pest or several pests by attracting them for feeding, breeding and survival. These crops are generally planted along the main crop as intercrop, as border or in strips. Insect management practices like insecticide spraying are confined to these crops. Vetiver can perform the function of a “trap crop” that is grown to attract a pest species in order to protect a nearby cash crop. Protection of cash crop may be achieved by

preventing the pest from reaching the crop, or by concentrating the pest in a portion of the field where it can be managed (Fig. 6).

Jakobi (2004), who farms 200 ha of commercially produced organic hoticultural crops in Zambia, has noted the control of maize stalk borer in his field of baby corn and control of leaf miners in peas as well as in coffee blocks. The maize stalk-borer control is more than the vetiver acts as a trap crop for the stalk-borer moth when it lays its eggs, whereas with the leaf miner it seems that the beneficial wasp population takes care of the leaf miners.

2.4.3 Dead-End Trap Crop: Shelton and Nault (2004) have identified another group of plants which are highly attractive to insects, but their offspring cannot survive on them. They gave them the new name of "dead-end trap crops".

Van den Berg, et al.(2004) indicated that vetiver was highly preferred for oviposition by *Chilo partellus,* but that larval survival on this plant was extremely low. This makes vetiver a potential "dead-end trap crop" to concentrate *C. partellus* oviposition away from the maize crop and reduce subsequent population development (Figs. 7-10).

Van den Berg (2007) has investigated the characteristics of vetiver grass and its effect on pest infestation levels in maize under field conditions. He planted vetiver in close proximity to the main crop with the aim of attracting target pests away from the main crop. He found that vetiver was highly attractive to the target pest, the stem borer (*C. partellus*). As vetiver allowed no or very low larval survival, it could actually be termed a "dead-end trap crop" for certain pests in certain environments. Significant reductions in stemborer damage to maize have been observed in fields surrounded by vetiver grass in South Africa and Malawi.

2.5 Kinds of Objects Trapped by Vetiver

There are two main kinds of objects trapped by vetiver, namely:

2.5.1 Non-Living Objects: These are non-living objects that are trapped by the vetiver hedges. There are five categories of non-living objects, namely (1) sediment (2) fertilizer, (3) pesticides, (4) agrochmicals and nutrients, and (5) heavy metals. These will be discussed in Chapter 3.

2.5.2 Living Objects: These are living objects that are trapped by the vetiver plant. There are three categories of living objects, namely (1) insects, (2) nematodes, and (3) weed seeds. These will be discussed in Chapter 4.

3. NON-LIVING OBJECTS TRAPPED BY VETIVER

These are all non-living objects brought down from higher areas along with the runoff water, either above- or underground. Such objects can be categorized as follow:

3. 1 Sediments

Vetiver System is a simple and economical method to conserve soil by slowing the velocity of water and trapping sediment, filtering out nutrients. Vetiver grown on the contour hedges along the slope acts as a living wall, retarding the running water and trapping soil sediment, large and small, carrying along with the water and deposited at the front of the vetiver line. Vetiver hedgerows have been shown to be very effective in trapping both fine and coarse sediments in runoff water from both agricultural and industrial lands (Meyer, et al. 1995; Truong, et al. 1996b; Truong, 1999). These sediments need to be trapped on site or they will pollute and silt up streams, road and other infra-structures. Chemical pollutants also often adsorbed by these sediments, which when trapped by vetiver hedges, will lessen off-site pollution (Truong and Baker, 1998). These materials help adding soil fertility and moisture at the front of the hedges (Figs.11-16).

Vetiver hedges planted across waterways and drainage lines reduce erosion and trap both coarse and fine sediments, resulting in less sediment in the dam water (Truong and Baker, 1998). Vetiver traps the silt and reduces the speed of the runoff. Thus more water has time to seep down to lower layers of the soil, while the rest flows through. Over time sediment accumulates at the front of the hedgerow, increasing and eventually forming a natural terrace. In North-eastern Thailand, corn plantation along and across slope has different amount of soil loss ranging from 7.81 to 5.91 tons/ha, and ploughing and planting corn across slope could decrease soil loss around 33.6% (Suriyo and Vongkasem, 2002). Vetiver strip across the slope could decrease soil loss in average to 4.81 tons/ha. In the 2nd year, vetiver planted in double row and developed into dense strip could reduce soil loss by 50-90%. Such a deposit results in the formation of natural terrace, which is about 30 cm high a year (Fig. 2).

The amount of sediment trapped by the vetiver hedges was found by Beya and Truong (2002) to vary with the conditions of the hedges. When the hedges were complete (with no gaps), up to 200 mm deep of sediment was trapped, with the sediment texture being made up of sand and clay and less than 5% silt.

Baay, et al. (2015) used vetiver as silt barriers in controlling runoff from open pit mines to decrease the silted water velocity as it pass through the vetiver root system and to determine relationship of vetiver density and efficiency in trapping silt. It was found that

the amount of total silt collected in the discharge reservoir significantly decreased while the vetiver roots helped in lessening the velocity of inflow, thereby encouraging settling.

Wallace Genetic Foundation funded research relating to excess agrochemicals and pesticides by Paul Truong and his colleagues (Truong, et al. 1999a) in Australia have demonstrated this quite convincingly to the extent that the Queensland Department of Natural Resources is requiring all cotton farmers to include vetiver sediment traps in their farm plans.

3.2 Fertilizers

VS can be a very effective and low-cost means of trapping fertilizers in runoff water from agricultural lands. It can be used to trap runoff following fertilizer applications. Vetiver will trap most of those fertilizers and prevent them getting into primary water sources. Many researchers have found that elevated concentrations of fertilizers in runoff were reduced after the runoff had filtered through the vetiver strips.

With respect to the binding nature of the fertilizers, they are separated into two types, namely non-particulate-bound and particulate-bound fertilizers.

- **Non-particulate-bound fertilizers:** Vetiver grown close together in hedges can trap fertilizer residue the farmers applied to their crops and carried along with water above or underground. Such residue deposited in front of the vetiver hedges, which act as a living dam, thus trapping fertilizer, resulting in increasing soil fertility in front of the vetiver hedges, making such soil more fertile. Although the absolute nutrient losses in soluble form are negligible, yet their effect can be observed from the luxuriant growth of the plants growing in front of the vetiver hedges (Suriyo and Vongkasem, 2002).
- **Particulate-bound fertilizers:** Vetiver hedges were highly effective in trapping predominantly particulate-bound fertilizers. Troung, et al. (2000) have found that in the sugarcane fields in the Johnstone River catchment, tropical Queensland, Australia, particulate-bound fertilizers such as P and Ca were trapped in front of the vetiver hedges. The key to controlling offsite nutrient movement in runoff is therefore to control sediment movement. If the sediment can be effectively trapped at source, the degree of downstream pollution will be greatly reduced. Truong, et al. (2000) were also successful in using vetiver hedgerows to trap a high concentration of P in cotton plantation in Australia. The reduction of P concentration ranged from 26% for zero-till burnt-trash blanket treatment to 67% for rotary hoe and 69% for zero-till green-trash blanket. The largest amount of Ca trapped by the vetiver hedges was in the rotary-hoed treatments and when fertilizers were applied on the surface.

3.3 Pesticides

Vetiver hedges trap pesticide residues carried along the water and deposited in front of the vetiver hedges. In addition, the concentration of insecticides, fungicides, bacteriocides and herbicides carried along with the water is much reduced when passing through vetiver hedges, which act as a sieve for these pesticides. Elevated concentrations of pesticides were reduced after the runoff had filtered through the vetiver hedges. Thus, the water passing through the vetiver hedges contains less concentration of these pesticides every time they pass through each hedge of vetiver. Some years ago vetiver hedge traps were used in Thailand to reduce the outflow of golf course pesticides to the water system.

Among the important pesticides trapped by vetiver hedges are the following:

- **Insecticides:** In northern highland of Thailand, it was found that vetiver planted in line along with cabbage on sloping land was able to trap such insecticides as carbofuran, monocotophos and anachlor. These insecticides were completely trapped such that none of them passed through to cause damage to the crops planted on the lowlands (Pinthong, et al. 1998).

  Truong, et al. (2000) were successful in using vetiver hedgerows to trap high concentration of endosulfan in cotton plantation in Australia. Vetiver hedges were planted in strategic locations at the end of tail drains in single and multiple rows on several farms in the Emerald Irrigation Area in September 1997. Plants and soil samples were collected and analyzed for suspended sediment, nutrient and insecticide concentrations at the end of the cotton season in February 1998. Samples were collected up and down the slopes of the hedges. Similar sampling was carried out after the following season. Soil samples were collected at various distances upstream and downstream from the vetiver hedges and analyzed for selected organochlorine (α, β and sulfate endosulfan) and organo-phosphate (chlorpyrifos, parathion and profenofos). During its first year of growth the vetiver hedges trapped 86% of total endosulfan in the sediment of runoff water and 67% of chlorpyrifos – compared with 65% of total endosulfan in the second year. These initial findings indicated that vetiver appears to be highly effective in trapping the sediment-bound chemicals - endosulfan and chlorpyrifos - two of the more commonly used insecticides. The high concentration of endosulfan in the trapped sediment resulted in higher endosulfan content in vetiver tops. While the vetiver shoot of the first hedge contained on average 0.43 mg/kg endosulfan, the shoots of the next hedge down slope only had 0.03 mg/kg, is a 14 times reduction.

- **Herbicides:** Truong, et al. (2000) were successful in using vetiver hedgerows to trap herbicides in cotton plantation in Australia. These herbicides included diuron, trifluralin, prometryn and fluometuron. It was found that during its first year of growth, vetiver hedges were not very effective in trapping diuron, but fluometuron levels were greatly reduced. In the second year, the vetiver hedge trapped 48% of diuron.

3.4 Agrochemicals and Nutrients

There has been increasing concern in Australia about water quality in streams and rivers. Particular concern is expressed about the likelihood of high levels of nutrients causing blue-green algae blooms in inland rivers in runoff which caused fish deaths in coastal rivers. Researches in both Australia and the United States have shown that soil erosion is the main factor contributing to the pollution of water.

Vetiver can act as a living trap that holds back agrochemicals and nutrients carried along the current and deposited right in front of the vetiver hedges (Truong, 1999b). This makes the soil more fertile. As vetiver can tolerate high concentrations of agrochemicals, thus can perform the function of phytoremediation quite well through the absorption of such chemicals into their roots. This is the most convenient and economic method of trapping agrochemicals and nutrients from cultivated land.

3.5 Heavy Metals

In the area of mining, mine tailing created a lot of problem as it contained heavy metals, not the ones that were being mined. The presence of traces of such heavy metals made it impractical to assemble, yet they were allowed to accumulate in the mine tailings, which upon leaching, were carried along with water to lower areas, causing a problem in contamination of water domestically used by the villagers in many areas in Thailand, such as lead in Klity Village, Thong Pha Phum, Kanchanaburi Province; cadmium in Mae Sot District, Tak Province; arsenic in Ron Phibun District, Nakhon Si Thammarat, etc.

In Thailand, Sripen et al. (1996) found that vetiver grass can trap substantial quantities of lead, mercury and cadmium in wastewater in Phetchaburi Province. Vetiver grown in single line performs its duty as a living trap for heavy metals, such as demonstrated by Srisatit, et al. (2003) and Johne and Watzke (2007) who used vetiver to trap arsenic carried along the current to the reservoir in Ron Phibun District of Nakhon Si Thammarat Province in southern Thailand. It was found that the water that passed through the vetiver hedges was clean and free from arsenic.

PLATES

Fig. 1: Vetiver hedges act as a living trap (Courtesy Dr. Pittayakorn Limthong).

Fig. 2: Vetiver hedges form natural terrace, 30 cm/year (Courtesy Mrs. Wilaiwan Wongkasem).

Fig. 3: Vetiver hedges grown alternatively in between vegetable plots help to trap fertilizers carried along with water to the vegetable plots.

Fig. 4: Vetiver hedge traps debris and sediment carried along with water and deposit them in front of the vetiver hedge

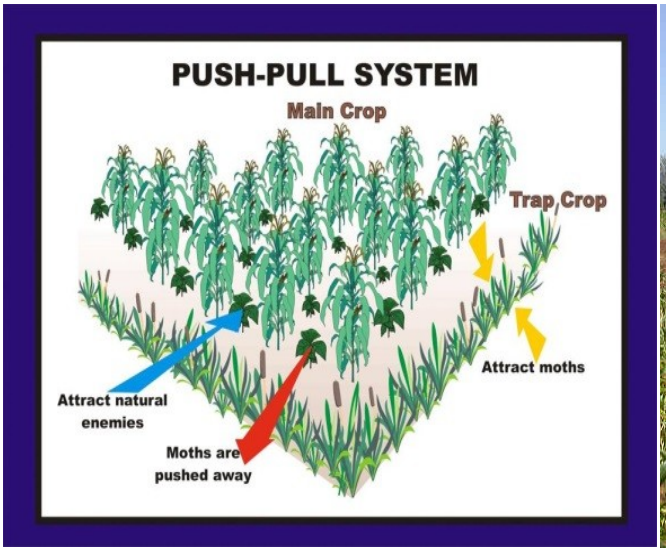

Fig. 5: Push-Pull System developed by Prof. Van Den Berg.

Fig. 6: Vetiver planted in rows to protect the field of corn plants in South Africa.

Fig. 7: Field trial with vetiver trap around maize in Malawi. (Courtesy Prof. J. van den Berg).

Fig. 8: Field trial with vetiver as trap around maize in Limpopo Province, South Africa (Courtesy Prof. J. van den Berg).

Figs. 9-10. Forming thick hedge and very fine filter when planted close together (Courtesy Dr. Paul Truong).

Figs. 11-14. Trapping soil, trash and fence post during a flash flood in Queensland, Australia (Courtesy Dr. Paul Truong)

Fig. 15-16. Trapping soil on farm land in Queensland, Australia (Courtesy Dr. Paul Truong)

Figs. 17-18. Trapping small and large rocks in quarry and mines in Queensland, Australia (Courtesy Dr. Paul Truong)

Fig. 19: Field trial with vetiver as trap around maize for beneficial in Limpopo Province, South Africa. (Courtesy Prof. J. van den Berg)

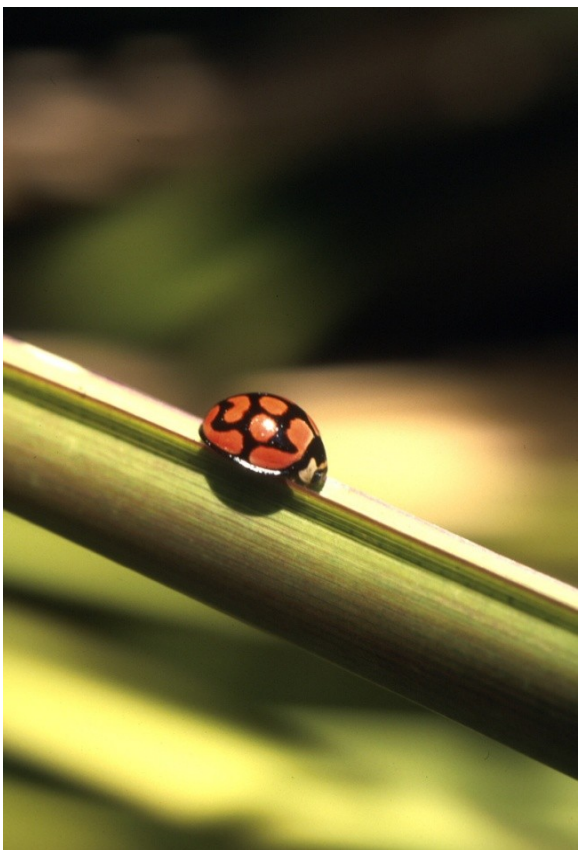

Fig. 20: Vetiver hedges provide refuges insects such as ladybird beetle (Courtesy Prof. J. van den Berg)

4. LIVING OBJECTS TRAPPED BY VETIVER

A number of living objects are trapped by vetiver. Among these are:

4.1 Insects

Insects are considered one of the most serious pests of crop plants. The use of vetiver trap is natural and economically safe in controlling the widespread of insect pests as demonstrated by the following cases:

Levy (1994) observed that the vetiver plant grown in close proximity to the sugarcane could inhibit the attack upon the sugarcane of certain insects such as the cane borer. He proposed that it may be due to the effect of insect trapping of the vetiver plant. Frances (2000) observed that the stem borers rather lay their eggs on the vetiver than on the sugarcane plant in San Salvador. The sugarcane plant seems to be healthy with very little attack of the stem borers compared with sugarcane plants in other fields that do not have vetiver along the side. As it has been observed that many insect species occur on vetiver grass, van den Berg (2006a) was of opinion that vetiver provides shelter, not only to a few potential insect pests, but also to a large number of general predators and parasitoids of insects that occur in the agro-ecosystems where vetiver grass is planted.

Glas (2006) did a study on oviposition and larval behavior of *Chilo partellus*, an important polyphagous insect pest of maize and sorghum in South Africa, to find out whether or not it can be controlled by using vetiver as a trap plant. In two-choice preference tests, he examined the effect of experience of maize and vetiver plants on the oviposition behavior of *C. partellus*. Both wild as well as laboratory-reared moths were tested. It was found that naïve female moths preferred to lay eggs on vetiver instead of maize. Wild moths with an experience on vetiver laid hardly any eggs in the two-choice tests, while lab-reared moths with an experience on vetiver showed clear preference for vetiver. It was concluded that female moths do not learn as they do not change their preference after having experienced oviposition on either maize of vetiver. Thus, maize plant does not have to become necessarily the most preferred plant for oviposition.

Van den Berg (2007) did further experiment to prove that vetiver could really perform its duty as a living trap to catch corn stem borer. The vetiver hedges growing around corn plant reduce the danger of stem borer infestation because it prefers to lay eggs on the vetiver leaves rather than on corn leaves. Having hairs on the underside of the leaves, the emerging young larvae could not bore the hole into the vetiver stem, thus fall down to the ground and die. Moreover, the vetiver plant is the host plant of predatory insects that overwinter on it, thus are able to eradicate stem borers that come in spring. He also found

a number of arthropods that act as predators on the vetiver rather than on corn plants, both in the summer and the winter. From such works, he developed an integrated pest management system, named, “the push-pull system” for insect protection (Fig. 5). From these studies, both in the laboratory and the greenhouse, he could demonstrate that the moth of *C. partellus* prefers to lay eggs on vetiver, and not on corn leaves (Figs. 6-10). From continuing studies in the greenhouse and in the field, he could demonstrate that the larvae of stem borer’s moth have less chance of survival on vetiver leaves. Consequently, vetiver behaves as a living trap for stem borer when grown in between rows of corn plants. Such a result could be applied in sugarcane field as well as in rice field.

4.2 Nematodes

In Ethiopia, a farmer planted chili pepper in between the rows of vetiver and found that the yield is much higher than of other growers who did not grow in such a manner (Grimshaw, 2009b). Although this case is anecdotal evidence, it may be possible that rows of vetiver plant could behave as a living trap for nematodes carried by the current along with soil sediment, thus could no longer move further and be destroyed with pesticides accumulated in the vicinity of the vetiver roots.

Since vetiver is commonly planted to prevent soil erosion in intensely cultivated areas, the question was asked what its effect might be on nematode numbers in the soil. Nematodes, especially the root-knot nematodes (*Meloidogyne* spp.), are important pests of vegetables and other crops (van den Berg, 2007). Observations were also made on resistance of vetiver to nematodes in Australia and Brazil. It can be concluded that vetiver grass is a poor host to the most abundant root-knot nematode species in resource-poor farming systems and that it is unlikely to result in increases in nematode populations when used as cover, companion or hedgerow crop.

4.3 Weed Seeds

Grimshaw (2009a) referred to the letter that Olsen and Skidmore from Queensland, Australia who wrote him the following: “The vetiver hedges delay the flow of water current and distribute soil mass that was carried along the current to deposit in front of the vetiver rows effectively. As a bonus are the weed seeds carried along with the current and soil mass and deposited in front of the vetiver rows, thus do not disperse to cultivated areas, thus the farmers could eradicate them without the use of chemicals.” However, although it is feasible, up to now, there has been no research work done to prove that vetiver hedges can really trap weed seeds.

5. BENEFITS DERIVED FROM USING VETIVER AS A LIVING TRAP

Among the benefits derived from using vetiver as a living trap are the followings:

5.1 Purification of Wastewater

Wastewater is water that contains liquid-borne waste products of domestic, industrial, agricultural or manufacturing industries. It enters the body of water in the forms of effluents and leachates. Purification of wastewater through the use of vetiver can be done before or after it enters the body of water (Chomchalow, 2004). Before entering the body of water, wastewater can be treated through the use of vetiver plants. Two such systems are already in use. The first, the Land Irrigation System, employs vetiver plant grown as crops to dispose both the large effluent volume and to strip soluble elements (particularly N and P), or filter sediment-bound chemicals. Many investigators were successful in using vetiver to trap contaminants from agricultural, industrial and garbage landfill leachates and effluents. The second, known as the Wetland System, where the low-lying area with water and aquatic plants is being used to purify wastewater. Natural and constructed wetlands have been shown to be effective in reducing the amounts of contaminants in runoff from both agricultural and industrial lands. The use of wetlands for removal of contaminants encompasses a variety of complex variety of biological processes, involving microbio-logical transformations and physio-chemical processes such as absorption, precipitation or sedimentation. Vetiver grown in these wetlands can be used trap contaminants from leachates or effluents. For example, vetiver is popularly used in trapping pesticide residues in the leachates, as well as from garbage landfill leachates. Likewise, wetlands are also used to trap contaminants from agricultural, domestic or industrial effluents.

5.2 Control of Algal Growth

Soluble N and particularly P are key elements for eutrophication of the lake or pond. Such a situation leads to blue-green algal growth in inland waterways and lake. The removal of these elements through the trapping of vetiver is considered by Truong et al. (2000) to be the most cost-effective and environmentally-friendly method of controlling algal growth. The Chinese scientists have also shown that vetiver could trap dissolved nutrients and reduced algal growth within two days under experimental conditions (Xia, et al. 1998; Zheng, et al. 1998). Thus, vetiver plant can be used very effectively to control algal growth in water infested with blue green algae. This can be achieved by both planting vetiver on the edges of the streams or in shallow parts of the lakes where usually high concentrations of soluble N and P occurred and by growing vetiver hydroponically on floating platforms, which could be moved to the worse affected parts of the lake or pond.

The advantages of the platform method is that vetiver top part, including leaves and young culms, can be harvested easily for animal feed, or used as mulch, mushroom medium, while the roots can be removed for essential oil extraction.

5.3 Pollutant Reduction

Vetiver trap has been demonstrated to reduce the risk of offsite pollution by agrochemicals and nutrients. As vetiver thrives in wetlands, it is therefore highly suitable for the wetland system to trap N and P from polluted water including discharge from aquaculture ponds. Excess nitrates, phosphates and pesticides are pollutants that create a problem to the soil particles. Vetiver can trap most of those particles and prevent them from getting into primary water sources. Paul Truong and his colleagues (Truong, et al. 2002) in Australia have demonstrated this quite convincingly to the extent that the Queensland Department of Natural Resources was requiring all cotton farmers to include vetiver sediment traps in their farm plans. Many years ago vetiver traps were used in Thailand to reduce the outflow of golf course pesticides to the water system.

5.4 Making the Soil More Fertile

Annually, a significant amount of nutrients are trapped by the vetiver hedges. Chemical pollutants also often adsorbed by the sediments, which when trapped by vetiver hedges, will not only lessen off-site pollution, but help adding soil fertility and moisture at the front of the vetiver hedges (Truong and Baker, 1998).

5.5 Pest Control

Trapping of living objects such as insects, nematodes and weed seeds rely on the “living wall” and “living dam” properties of vetiver. But the most important thing is the resistance to the attack by these crop pests that prevents them from destruction by these organisms. One thing that vetiver hedges have done well is pest control, whether they are insects, nematodes or weed seeds.

5.6 Phytoremediation

Pinthong, et al. (1998) who grew cabbage on steep slope on the highlands of northern Thailand found that vetiver hedges had an important role in the process of trapping and decomposition of agrochemicals, especially pesticides such as carbofuran, monocrophos and anachlor, preventing them from contaminating and accumulating in crops. Sripen, et al. (1996), on the other hand, found that vetiver can absorb substantial quantitites of lead, mercury and cadmium from wastewater.

6. DISCUSSION

6.1 Vetiver: A Miracle Plant

It has been well accepted that vetiver is a miracle plant as it plays a major role in soil and water conservation, reclamation, rehabilitation, phytoremediation, bioengineering, etc. The use of vetiver in soil erosion control and collecting soil sediment has been practiced for a long time, but the use of vetiver as a living trap is a rather new development that could be used alongwith other purposes in planting vetiver along the contour.

6.2 The Role of Vetiver Traps

6.2.1 In Integrated Pest Management: Vetiver system should play a role in a large technology for agro-ecology campared to its specified role of integrated pest management. Trapping of pests by vetiver is similar to other systems used in controlling of pests; it will never have efficiency in reduction of the number of pests in a long duration, but it should be a part of an integrated pest management.

6.2.2 In Environmental Protection: There has been a worldwide concern about the contamination of the environment of urban wastes and by-products of rural manufacturing and mini-industries. The largest parts of these contaminants are chemical by-products and heavy metals. Vetiver, which has been widely known for its effectiveness in erosion and sediment control, has been found to be able to trap such contaminants most effectively and in a natural way.

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