ABSTRACTS OF ALL KING AWARDS SUBMISSIONS

Content:

Total 42 papers

The contesting papers come from 15 countries, including 19 from Thailand, 5 from Venezuela, 4 from PR China, 3 from USA, 1 from Nigeria, 1 from Vietnam, 1 from Malaysia, 1 from Myanmar, 1 from Uganda, 1 from New Zealand, 1 from Ethiopia, 1 from Papua New Guinea, 1 from India, 1 from Kenya and 1 from Mexico

The six winning titles of the Award categories are shown in red font

RESEARCH

AGRICULTURAL

1. Reversing Soil, Water, Carbon and Nutrient Losses on Sloping Farmland: A Field Experience with Vetiver Technology and Usual Practice in South Eastern Nigeria

Effiom E. Oku Department of Soil Science, Faculty of Agriculture University of Abuja, Nigeria, West Africa

Abstract

From scientific land use, study, slopes are not suitable for crop production because of the hazards of soil erosion. Yet, many agricultural communities in Africa will have to meet SDG 2 and 1 by cultivating steeplands as large extent of their land range from moderate to very steep slope. A study on a 45 % slope in Nigeria introduced Vetiver Technology (VT) for protection of steepland farm. The aim was to monitor soil, water, carbon, plant nutrients losses, cassava and maize yield under Vetiver Grass Buffer Strips (VGBS) and Usual Practice (UP) (no vetiver). Twelve small-scale erosion plots each measuring 50 m x 3m (150 m2) were constructed with sedimentation drums installed at the foot slope to collect runoff and sediment loss from the field. Vetiver grass buffer strips planted along the contour on the erosion plots at an interval of 5 m, 15 m, 25 m and UP were the four treatments used. The treatments fitted into the Randomized Complete Block Design (RCBD) with three blocks. All the traditional agronomic activities were carried out within the alleys in all the treatments. The data collected were daily rainfall, soil loss, runoff, carbon and plant nutrient losses from eroded sediments, cassava tuber and maize grain yield. The data were subjected to analysis of variance at $P < 0.05$ level of significance. In the first year 29, 7 12 and 13 % of the total rainfall flow over the farm as runoff under UP, VGBS at 5, 15 and 25 m, respectively. The corresponding runoff in the second year was 21, 8, 11 and 11 %. Soil loss in the first year and second year under UP was 76 - 98 times and 12 - 13 times, respectively higher than the acceptable soil lost limit of 12. 5 t ha-1 yr-1 . Under VGBS at 5 m it was 3 - 23 times higher in the first year. In the second-year vetiver hedgerow curtailed soil loss to levels below the

acceptable limit. Soil organic carbon (SOC) loss on UP was 226, 107 and 74 % higher than losses on VGBS at 5 m, 15 m and 25 m, respectively. The low SOC loss recorded under VGBS plots shows VGBS provides an environment for soil to sequester carbon (SDG 13). Losses of major plant nutrients as N, P, K, Ca, Mg and Na were significantly higher on UP than on VGBS intervention plots. Fresh cassava tuber and maize grain yields were significantly higher under VGBS intervention than UP fields. The second year witnessed a decline in the yield of both crops under the UP. Whereas a sustainable increase in the yield of both crops were recorded under VGBS (SDG 2 and 1). This study shows the climate change mitigation and adaptation ability of VT. The VGBS if, established and allowed to allow to remain will, in the first year significantly curtail erosion and subsequently prevent erosion, correct, heal and restore erodible farmlands or fields (SDG 15). Keywords: Soil erosion, climate change, SDGs, steepland farming, soil conservation

2. Potential Use of Vetiver [Chrysopogon zizanioides (L.) Roberty] with Convolvulaceae and Fabaceae Crops for Soil and Water Conservation

Nisa Meesang1/ Wanraya Suthumchai1/ and Tanomkwan Tipwong1/
1/ Research and Development for Land Management Division, Land Development Department Chatuchak Bangkok THAILAND

Abstract
The potential use of vetiver [Chrysopogon zizanioides (L.) Roberty] with Convolvulaceae and Fabaceae crops for Soil and Water Conservation was studied which aimed to identify crops suit for enhancing soil and water conservation with vetiver. The experiment was conducted by selecting the Convolvulaceae and Fabaceae crops are commonly available in the research stations of the Department of Livestock, Land Development Department and Department of Agriculture in Thailand and further studying with the combination with vetiver during January 2015 to October 2017. The results showed that 23 samples crops were obtained and possibility to fulfill desirable characteristics when combination planted with vetiver. The five selected cropping patterns are mono vetiver, vetiver with three Fabaceae and vetiver with Convolvulaceae crops as 1) Mono Vetiver [Chrysopogon zizanioides (L.) Roberty] 2) Vetiver with Pintoi peanut (Arachis pintoi) 3) Vetiver with Caeruleum calopo (Calopogonium caeruleum) 4) Vetiver with Tropical kudzu (Pueraria phaseoloides) and 5) Vetiver with Roundleaf bindweed [Evolvulus nummularius (L.)] The experimental design was Randomized Complete Block Design with four replications. The results showed that Roundleaf bindweed is the most appropriate crop selecting for combination planting with the early stage of vetiver. It showed the highest speed and percentage of soil covering surface in 5 months with the percentage of 99.47, however it wasnot statistical significant difference ($p < 0.01$) from the Pinto peanut with the soil covering percentage of 94.10. The combinations of vetiver and cover crops showed slightly enhance some chemical and physical soil properties than mono vetiver pattern. The combination of vetiver and Roundleaf bindweed had the highest percentage of soil particle size (2.0 - 8.0 mm.) with 45.27 but it was not statistical significant difference from the combination of vetiver with Pintoi peanut with 39.08 percent. In addition, there were simultaneously had the highest mean weight diameter and aggregate stability of the combination of vetiver and Roundleaf bindweed with 2.48 mm and 11.84 percent, respectively. However, it was not significantly different from the combination of vetiver and Pintoi peanut. The five cropping combinations were not significantly different in both bulk density and soil moisture content. Keywords: vetiver, Convolvulaceae, Fabaceae, physical soil properties, and soil and water conservation.

2. Response of decomposition patterns, soil aggregation, microbial activities and soil organic matter to different organic residue quality application in salt-affected sandy soil

Aunnop Puttaso and Sakuntala Supasai

Abstract

Abstract The objective of this study was to investigate decomposition pattern and N release, microbial activity, soil aggregate formation and soil organic matter (SOM) accumulationin response to vetiver grass residue and available locally residues under vetiver grass plantation in salt affected sandy soil. The study area was located at Ban Ngio-Kao, Tambon Non Pradu, Sida district, Nakhon Ratchasima province. A randomized completely block design with 3 replications and 5 treatments were employed. All organic residues such groundnut stover, vetiver grass, rice straw and eucalyptus, were applied at rate of 10 t ha-1 . This results showed decomposition rate at early stage (k1) was higher than later stage (k2). Decomposition rate k1 and k2 of double pool model were negatively correlated with C and C/N and positively correlated with N. In particular k2was highly negatively correlated with lignin but positively correlated with cellulose. The residues with sufficient N content and moderate amount of carbon, lignin and cellulose, like vetiver grass residues, were most effective in accumulating SOC (4.13 g kg-1).Also, high efficiency of C utilization (low qCO2) of decomposer communities especially in vetiver grass with lowest qCO2 and CO2-C loss. Soil physicallyprotected, termed soil aggregate and mean weight diameter (MWD), soil microaggregates (Mi,

2. Effect of Shading Nets on Growth of Vetiver Grass

Naruemon Phongaksorn

Abstract

Study on shading on growth and survival rate of vetiver grass under shading net could be used for decreasing the limiting factor in soil conservation under shaded areas. The objective of this study is compared growth of six ecotypes of vetiver grass under a 50% and 80% shade level to the full sun plants. The experiment was proceeded in a split plot design in a randomized complete block design with three replications on properties of Sattahip series, a sandy soil, at Khao Hin Son Royal Development Study Center, Chachoengsao province, Thailand during June 2012 to June 2015. The main plot had three; A1) 100% sun light, A2) a 50% shade level and A3) an 80% shade level. Plus, the sub plot had six ecotypes of vetiver grass; B1) Sri Lanka, B2) Surat Thani, B3) Roi Et, B4) Ratchaburi, B5) Chanthaburi, and B6) Prachuap Khiri Khan. The results showed that Sri Lanka was not shade tolerant, but can survive in the first year, decreased significantly in the second year and eventually died off in the third year. On the contrary, the rest of ecotypes tested were shade tolerant throughout three years with differed significantly in tiller per clump numbers, plant heights, and survival rates. In crease of the number of tillers per clump illustrated that that make it ideal for soil conservation in shaded areas.

3. The Study of Soil and Water Conservation Measure in Macadamia Plantation on Soil Erosion and Soil Moisture Content on Highland

Srunnupong Chaiwattanagul,

Abstract

The study of soil and water conservation measure in macadamia plantation on soil erosion and soil moisture content on highland in land development zone on Mae chan Sub Watershed, Maesalongnong Sub District, Mae fah luang District, Chiang rai Province. Was conducted at Ban Tongjasai Moo 13 Maesalongnong

District, Mae fah luang District, Chiang rai Province. In the Doi Pui series : Dp. During of the month October 2013 to the month December 2016. The objective was to study the soil and water conservation measures suited to the growing of macadamia on highland. The amount of soil loss. Moisture in soil. Physical and chemical properties of the soil. The experimental design was Randomized Complete Block Design with 6 treatments 3 replications as : 1.The fruit tree plantation no soil and water conservation 2.The fruit tree plantation use vetiver grass (use the V.I.2.5 meters) for soil and water conservation 3.The fruit tree plantation use Hillside ditch (use the V.I.4 meters) for soil and water conservation 4.The fruit tree plantation use Hillside ditch (use the V.I.4 meters) with the vetiver grass outside Hillside ditch for soil and water conservation 5.The fruit tree plantation use individual basin for soil and water conservation 6.The fruit tree plantation use hillside ditch (use the V.I.8 meters) for soil and water conservation The results showed that. The macadamia plantation use Hillside ditch (use the V.I.4 meters) with the vetiver grass outside Hillside ditch for soil and water conservation. As a result, the physical properties of the soil improved. The bulk density of soil decreased. The total porosity was highest. The chemical properties of the soil. The pH of soil increased. The organic matter and potassium in soil content decreased. There was a tendency to decrease, but also higher than other methods. The amount of phosphorus content in the soil increased was highest. The water content in soil is increased maximum. The amount of soil loss is lowest. The loss of nutrients to the sediments. A loss of organic matter total nitrogen Available phosphorus and extractable potassium in soil to sediment lowest. The growth of macadamia. The macadamia plantation use Hillside ditch (use the V.I.4 meters) with the vetiver grass outside Hillside ditch for soil and water conservation. Macadamia has the height average higher. The wide of macadamia shrub average maximum. The girth of the stems macadamia average maximum. The macadamia plantation use Hillside ditch (use the V.I.4 meters) with the vetiver grass outside Hillside ditch for soil and water conservation. It's the right approach. to be used as a measure of soil and water conservation with the cultivation of macadamia in highland. The right approach is followed by the macadamia plantation use vetiver grass (use the V.I.2.5 meters) for soil and water conservation.

4. Application Of Vetiver Grass Vetiveria Zizanioides As A Trap Plant For Controlling Rice Stem Borer Chilo Suppressalis In China

Lu YH, Zheng XS, Gao GC, Xu HX, Lu ZX* ***Institute of Plant Protection and Microbiology, Zhejiang Academy of Agricultural Sciences***

Abstract:

Rice is one of the most important staple foods in China and it is at risk of attack by rice striped stem borer Chilo suppressalis, which occurs in most rice growing regions in Asia. In recent years, more severe C. suppressalis outbreaks have been observed in China due to changes in the resistance to the dominant insecticides. Control is primarily dependent on the application of chemical insecticides and resistance is an important contributing factor in the outbreaks. As a result, the quality and security of rice products and the ecological and environmental integrities are threatened. Recently, environmentally friendly pest

management measures, such as trap plants have been introduced and adopted to manage C. suppressalis and greatly reduced the use of insecticides in China. Results in our studies indicated that the vetiver grass (Vetiveria zizanioides) is a dead-end trap plant that can effectively attract the adult females of C. suppressalis to lay eggs on it but where larvae are unable to complete their life cycle. The contents of total protein, cellulose, total sugar, amino acid and other nutrient contents in vetiver were significantly lower than those in rice. The protease, amylase, trehalase and sucrase enzyme activities of C. suppressalis larvae on 3rd day after fed (DAF) on vetiver were significantly lower than those in the larvae fed on rice; and on the 6th DAF, the activity of P450 enzyme in the larvae fed on vetiver was significantly lower than that in the larvae fed on rice; and the esterase activity of C. suppressalis larvae on the 9 th DAF on vetiver was significantly lower than that in the larvae fed on rice. Compared to glutathione S-transferase (GSTs) activity

of the 3rd instar larvae feeding on rice, the enzyme activity of the larvae feeding on vetiver was also decreased, however, there was no significant difference by the statistical analysis. In addition, vetiver significantly inhibited the expression levels of CsCYP6SN3 and CsCYP306A1 in 3rd larvae after feeding. RNA interference showed that silencing CsCYP6SN3 and CsCYP306A1 genes dramatically reduced the pupation rate and pupa weight. Feeding on vetiver after silencing CsCYP6SN3 and CsCYP306A1 led to higher mortality compared with feeding on rice. These findings implied that the expression levels of CsCYP6SN3 and CsCYP306A1 were associated with the lethal effect of vetiver against C. suppressalis larvae. This paper reviews the application and mechanism of vetiver grass as a trap plant to control C. suppressalis in the paddy field based on our recent results. This environment-friendly technology for management of C. suppressalis not only reduces the population of C. suppressalis and use of insecticides but also increases the diversity and abundance of natural enemies, provides better environmental conditions and a strong guarantee of secure production of rice. We have used vetiver grass to control rice stem borers as the key component of an eco-engineering technology, which has been listed as a national recommended technology by MARA of China since 2014, in 270,000 ha of rice in 14 provinces of southern China. This has resulted in a 70-80% reduction in insecticide use, and increased farmer income through cost reductions of insecticide application, and quality improvement of rice. Keywords: rice, vetiver grass, trap plants, rice stem borer, Chilo suppressalis, control

5. Study the factors of decision to grow vetiver grass among farmers in the northern and north eastern regions.

Isariya Meesing, Kamalapa Wattanaprapat, Pornpat Nopmalai ***Research and Development for Land Management Division Land Development Department***

Abstract

The objectives of this research were to study 1) Social-economic conditions of some farmers,2) Factors for the decision to grow vetiver grass, and 3) Problems, Obstacles and Suggestions for planting vetiver grass.The study group,consisted of 300 vetiver grass farmers in the northern and northeastern regions of Thailand. The results were as follows Social- economic conditions of the farmers in the northern region were mostly male, whilst in the northeastern region, most of the farmers were female, age over 45 years old. No more than 4 family members have ever received general agricultural training. Or have received information and knowledge about vetiver grass from staff from the Land Development Department. Also most northern and northeastern farmers have the privilege of holding land as title deeds. The total arable land occupied is between 11 - 20 rai, per farmer in the study group. Income derived in the previous year averaged 50,000 baht and there was also sources of credit from the Bank for Agriculture and Cooperatives. Vetiver grass conditions most of the northern farmers have 1-2 rai of vetiver cultivation, but most of the northeastern farmers have less than 1 rai of vetiver cultivation. Most northern farmers planted to prevent soil erosion. But most northeastern farmers grow for sediment deposits. But both farmers use bare roots and also received vetiver grass seedlings from the Land Development Department. Farmers in both regions sow during the months of July through until September Vetiver grass seedlings are planted at 2 per hole, with no fertilizer for the bottom of the hole. Rarely watering vetiver no planting, repairing, cutting leaves and not propagating as well. Factors affecting the decision to grow vetiver grass among farmers in northern region.

1.2 NON AGRICULTURAL

1. Root architecture, root biomechanical properties and root reinforcement of two contrasting vetiver species for slope stabilisation

Suched Likitlersuang and Trung Nghia Phan. ***Faculty of Engineering, Chulalongkorn University***

Abstract:
Root system architecture, root biomechanical properties and root mechanical reinforcement are the important indicators for choosing vegetation species in soil bioengineering. Although the vetiver species (i.e., Chrysopogon zizanioides and Chrysopogon nemoralis) has been advocated for use in slope stabilisation, the engineering properties of these two vetiver species were still limited in the literature. This study aimed to comprehensively measure and report the engineering properties of vetiver species for applying in slope stabilisation. A series of semicontrolled laboratory experiments were performed to provide intensive dataset of root traits, root biomechanical properties, and mechanical reinforcement of two vetiver species. Two subspecies of C. nemoralis A. Camus (highland specie called Huai Kha Khaeng) and C. zizanioides L. Nash (lowland species called Songkhla 3) were selected in this study. A rhizoboxes system was developed to observe the root system architecture without any disturbance on vetiver root system. A uniaxial tensile strength was tested on fresh roots to determine the root biomechanical properties (i.e., tensile strength and modulus). In addition, a direct shear test was conducted to measure the mechanical reinforcement of rooted soils. The results exhibited that the root system architecture observed by rhizoboxes highlighted the fast growth ability of the two vetiver species. The results also showed that the lowland vetiver roots occupied more area than the highland roots under the same growth conditions. As the results obtained from uniaxial tensile test and direct shear test, the strength and reinforcement of highland roots were comparable with those of lowland species. This study confirmed the potential application of both highland and lowland species for slope stabilisation. Keywords: soil bioengineering, root architecture, root area ratio, root tensile strength, root reinforcement

2. Vetiver system with engineering enhancement for slope and coastal stabilization

A. Jotisankasa,

Abstract
The application of vetiver system (VS) for erosion control and shallow slope stabilization has been successfully adopted in many parts of the world. However, given the more extreme climatic conditions nowadays, i.e. long-term drought, ever increasing erosive energy of surface water and more intensive rain, some engineering enhancements are required in some cases especially during early establishment of the grass, to maintain VS in a good condition to fulfil its full potential. Such VS engineering enhancements and the related case studies are reported in this paper, namely vetiver nursery long tube, automatic irrigation, hydrated polymer gel, and various kinds of geosynthetic bags, gabions and timber piles in front of the VS. The mechanical behaviour of vetiver root- permeated soil during shearing tests in the laboratory is also discussed which demonstrated the optimum moisture condition at suction of around 10-20 kPa at which the rate of increase in strength with roots became greatest. Two cases of engineering enhanced vetiver system are then reported, namely, a rural road slope, along Kanchanaburi-4088 route in Kanchanaburi province, western Thailand, and a coastal area stabilization in Sittiporn Kriddakorn Research Station, Prachuap Khiri Khan, Thailand. The findings of rural road case demonstrated the efficiency of vetiver long tube and hydrated polymer-gel to maintain the VS when planted in dry season. The coastal case showed that irrigated salt-tolerant type and Surathani ecotype of vetivers could survive the beach front condition. The measured root area ratio and soil suction were used to calculate the increase in shear strength at the soil surface to demonstrate their efficiency. Overall, it was found that vetiver mixed with other species of local trees and

grasses, namely, Derris indica (Lamk.) Benn, Ischaemum muticum, and Ipomoea pes- caprae, with geotextile bag, timber piles and gabion toe wall provide an effective solution to coastal protection.

3. Volatile Organic Compounds And Aroma Profile Of Thai Vetiver Roots Oil Obtained By Using Different Extraction Methods

Peerakan Kietthanakorn, Sornkanok Vimolmangkang, Jittima Amie Luckanagul

Abstract

Vetiver grass (Vetiveria zizanioides) is one of the ingredients found in almost every fragrance and perfume formula. The characteristic notes of vetiver include Woody, Earthy, Rooty, Balsamic, and Amber odour. This study aimed to compare the production process on the quantity, appearance, composition and aroma profile of Thai vetiver extracts. Different methods of vetiver roots extraction were used to produce vetiver roots oil such as Hydro-distillation (HD), Solvent extraction (SE), and Supercritical carbon dioxide extraction (SCE). Comparing all extraction method performance, SCE clearly showed the highest yield of Thai vetiver oil at 2.15 ± 0.25 (60 °C,2 h.), followed by SE and HD at 1.02 ± 0.08 (60 °C,6 h.) and 1.12 ± 0.22 (100 °C,24 h.), respectively. The yields of vetiver roots oil using SCE was observed to be greater compared with HD and SE. It could be hypothesized that supercritical fluid can better penetrate in vetiver roots leading to the efficiency in extracting both volatile organic and non volatile organic compounds. On the other hand, the Gas Chromatography - Mass spectrometry (GC-MS) analysis showed that HD provided a larger variety of components (a total of 28 VOCs were detected), such as Terpene, Sesquiterpenes, Alcohol, Ketone, Aldehyde and Ester, while the extracts from SCE (10 compounds) and SE (10 compounds) were mainly composed of

Terpene and Sesquiterpenes. Furthermore, the 8 trained panellists defined the terms, 5 aroma description (woody, earthy, spicy, fruity and balsamic) from the resulting extracts. They stated that all methods presented strong woody note. Interestingly, SFE extract shared the similar characteristics with Fresh Vetiver Roots with more pronounced spicy note. SE extract dominated earthy note, while extract from HD had more balsamic and fruitier note.

4. Comparison of Cold Tolerance of Four Young Vetiver Grass Cultivars: Multiple Year Trials at Two Locations in the United States

Eric. Wiediger , ***Leachate Specialist***

Abstract

Vetiver (Chrysopogon zizanioides) is a unique perennial clump grass that has shown a remarkable ability to solve complex environmental problems due to extraordinary characteristics, including its deep root system, ability to uptake large volumes of water and nutrients, and tolerance to extreme climate and environmental conditions. In the United States, Leachate Management Specialists (LMS) is a leader in applying the vetiver system as a disposal solution for landfill leachate. Its Phyto-Utilization™ system pumps the liquid to rows of vetiver or trees on top of the landfill where it is distributed through a drip irrigation network. However, using vetiver for this purpose is severely limited in geographic area to only the warmest regions of the country. One of vetiver's limitations is freezing temperatures; although, as a tropical grass, it has a relatively strong tolerance to the cold. During frosty conditions, aboveground biomass becomes dormant, but the underground corm survives and can regrow quickly. When the ground or corm freezes however, the plant

may not survive. Insulation helps protect the plant and can be in the form of biomass, soil, mulch, snow, plastic, or other material. Young vetiver may be especially vulnerable to the cold because it lacks the biomass insulation. A study conducted between 1999 and 2001 found that differences in cold tolerance exist between the vetiver cultivars, and soil freezing at 15 cm underground may be the critical factor for survival. To provide supplemental research to the earlier study and to help determine where vetiver could be planted with high probability of survival from the first winter, we wanted to compare cold tolerance of young vetiver using four of the same cultivars in two separate locations in the US. Because the vetiver system has become an important tool to protect water resources, soil, and in the fight against climate change, it is important to determine the plant's potential geographic limits to maximize where it can be applied in the world. The results of the study support the earlier conclusions that survival depends on if the corm or ground freezes, although cultivars may differ and younger plants are more susceptible with exposed bases and could still die if soil under the surface does not freeze. It also appears snow and biomass help insulate the plants from freezing. Vetiver that is five or six months old has a 50% survival rate when the soil temperature at 5 cm underground drops to near freezing conditions and/or air temperature lowers to about -14°C. Vetiver that is one or two months old may die when air temperature drops to -5°C and/or soil temperature at 5 cm remains slightly above freezing.

5. Using Vetiver Phytoremediation Technology To Mitigate Dioxin-Contaminated Soils At Bien Hoa Airbase, Dong Nai, Vietnam

Ngo Thi Thuy Huong, ***University***

Abstract

Agent orange, which was sprayed over a large area of central and southern Vietnam during the Vietnam War, is still a problem that causes health issues and must be resolved as soon as possible. This research aims to determine: (1) the ability of Monto vetiver to phytostabilize dioxin-contaminated sites, preventing offsite contamination; and (2) the effectiveness of Monto vetiver in the remediation of dioxin-contaminated soils at Bien Hoa airbase. The genotype Monto vetiver (Chrysopogon zizanioides L.) was chosen for this study because it had previously been used successfully in similar research in Australia. The research was divided into two phases. Phase 1 lasted from November 2014 to November 2016. Vetiver grass was planted in two groups of 100 m2 each: the first (G1) received DECOM-1, a soil supplement that promotes the growth of indigenous microorganisms in the rhizosphere, and the second (G2) received no soil supplement. The third group (G3) was left empty (without Vetiver). The initial dioxin levels in the soil were approximately 1,500-5,500 ppt TEQ. The findings demonstrated that Vetiver could grow well in dioxin-contaminated soils, forming a thick land cover with dense root systems that can stabilize dioxin-contaminated soils, preventing erosion and offsite contamination. Analyses of soil and plants revealed that Vetiver could absorb dioxins into its roots, which were then transported to its shoots. Dioxin levels in soil were reduced significantly in G1 and G2 compared to the first sampling time (decreases of 38% and 24%, respectively) but not in G3. Phase 2 was designed and carried out from November 2019 to 2021 to confirm and explore further the results of Phase 1. The experiment included two groups with three replicates of 100 m2 each: the experimental group with Monto vetiver (FT) and the control group (FC) without Vetiver. With the improved design, this Phase confirmed the ability of Vetiver in soil stabilization and clearly showed that the Vetiver treatment (FT) effectively reduced soil erosion and contaminant runoff compared to the FC group (115 vs 325 kg/100 m2 at the 40th month. The activity of enzymes (CYPs and GSTs) also showed that detoxification and transformation of dioxins could occur in the Vetiver rhizosphere and root system. In conclusion, these results confirmed that Monto vetiver is suitable for stabilizing dioxins in soil structure and preventing their runoff, as well as the phytoremediation of moderately dioxin-contaminated sites. These two projects were funded by the Ministry of Natural Resources and Environment of Vietnam (2014-2016) and USAID (2018-2021)

6. Vetiver-Enhanced Microbial Fuel Cell for Household Wastewater Treatment, Electricity Generation, and CO2 Sequestration

T. Phenrat*, J. Lawan, S. Wichai, C. Chuaypen, S. Kirdkoh *Naresuan University,*

Abstract

In this paper, we present an unprecedented vetiver-driven innovation called vetiverenhanced biochar-sediment microbial fuel cell (VEB-SMFC) to simultaneously tackle three global grand challenges including 1) climate change, 2) poor sanitation, and 3) inequality. With the help of vetiver, the VEB-SMFC sustainably converts wastewater to electrical energy while captures all CO2 generated in the process. Conceptually, household wastewater from fat, oil, grease (FOG) trap flows into a VEB-SMFC, where microbes transform organic contaminants in wastewater (as BOD and COD) to CO2, H+ , and electron via biological oxidation in an anode chamber using oxygen continuously supplied by vetiver rhizosphere. Electrons are then harvested by a reading light or a landscape light as an external circuit while CO2 is captured by the vetiver, and water is produced in a cathode chamber of the VEB-SMFC as the final byproduct. Noticeably, this vetiver-based microbial fuel cell alleviates poor domestic sanitation by appropriately treating wastewater, reduces climate crisis by capturing all CO2 emission from the process, and provides free electricity to attenuate inequality in a rural area. In addition to the Thai rural areas, this novel concept is beneficial for 13% of the world without access to electricity. This study started with a fundamental laboratory study to discover the role of vetiver rhizosphere in the anode chamber, which makes VEB-SMFC able to sustain the electricity generation far better than a typical SMFC. Optimal design was obtained in term of electrode selection, chamber amendments, and biological aeration by vetiver. In the first laboratory experiment, we determined the best condition for SMFC without vetiver. We found that packing the cathode chamber with AC yielded a maximum PD of 109.39 mW/m2,959 times greater than without AC in the cathode chamber. Nevertheless, with this SMFC configuration, the power generation declined 75% within 8 days, in a good agreement with the observed decline of microbial growth in the SMFC. Here is where vetiver enhancement plays essential roles. We found that planting vetiver to the anode chamber eliminated the problem of unsustainability of electricity generation presumably by two main mechanisms. First, vetiver served as a biological aerator, continuously transferring oxygen through vetiver rhizosphere to the aqueous phase (wastewater) of the anode chamber of the VEB-SMFC. Second, vetiver rhizosphere also acted as a host for aerobic microbes in the system, making the microbes healthier and more active in contaminant degradation as evident in the greater abundance of aerobic microbes in the VEBSMFC in comparison to the SMFC alone. Furthermore, we examined a pilot-scale applications of VEB-SMFC consisting of 30 units with the total treatment volume of 312 L; each unit has an area size of 0.25 x 0.25 m and a volume of 15.6 L/cell. We found that, with the hydraulic retention of 7 days, the pilot VEBSMFC can remove 85.8% of COD from the FOG trap wastewater from the Royal Thai Air Force Wing 46 Hospital in Phitsanulok, Thailand. Moreover, it can generate electricity of 26.29 W/m3 per unit cell continuously for 1.5 years. This electricity is sufficient for serving as a household reading light or a landscape light at night. Moreover, this system has a negative carbon dioxide emission because it sequesters 0.35 kgCO2/year per unit cell. In 10 years, its economic value is 7 times higher than the investment budget, and its social value is 15 times higher than the investment budget. Last but not least, this innovation can be easily disseminated to laypeople in a rural area anywhere in the world because steps to make VEB-SMFC is very simple with minimum training requirement. This research is one of a kind as it opens a new door for vetiver-enhanced technology that has never been reported to ORDPB, the Vetiver Network International, or the Pacific Rim Vetiver network before. It helps reshaping the answer for the frequently asked question “What do we get from cultivating vetiver”? The answer obtained from this research will be “we get free electricity, get our wastewater treated properly, and get to help the world fight climate change with the social return of 10 times greater than the effort we contribute.”

7. CultIvation Of Vetiver Stems Through Application Of Hydrponic Method

Mohamad Ariffin Khan Bin Mohamad Yusuf

ABSTRACT

The main objective of presentation is to exhibit an innovative idea where vetiver is cultivated in mass yet with limited spaces. Thus, in pursuing this object, it was decided that a non-conventional way of cultivation need to be identified and put into practice. In this effort, an idea of cultivating vetiver via employing the principle of hydroponic was chosen. In this exercise, the key element is 'zero-soil' cultivation. This means the existing common practice with soil being used as media is no longer a choice. Also, the common way of planting vetiver seedlings will be by having a huge area to be utilised and definitely lots of media such as soil is needed. In this case the subjects are not one of the options. What are the driving forces for such an idea? The entrepreneur is facing a number of limitations which are challenges that need to be overcome. This is so as the needs or requests from public is growing on the supply of vetiver seedlings. Challenges that need to be managed for this purpose are space constraints, resources limitations, labour intensive planting, and bulky seedlings handling. In traditional methods of vetiver farming, in order to be able to meet market needs, huge areas would be required. However, in this, space is a stumbling block. Thus, and idea is needed where huge production volume is required due growing mass awareness on the benefits of planting vetiver seedlings on hill slopes as a stabilising agent for the erosion prone surface. In tandem with the abovementioned, volume of prepared media, ie soil with other ingredients or soil health agents would be huge and poses challenges to the entrepreneur. Thus, there is a need that such requirements being taken out or reduced from the equation. Thus, the idea or thought of zero-soil cultivation. Subsequently, with such a huge area requirement and lots of media, this would definitely translate into high labour intensive activities. Again, this is not an option as labour extensive simply means higher planting costs. Thus, the old method of planting on ground surface of prepared plots would defeat the idea of 'ease planting'. Page 2 of 16 Lastly, another main challenge where once the seedlings are old enough and ready for transplanting, seedlings with media attached to the young roots for transplanting would be quite a hindrance to handling method. This would mean that bulk handling would be involved. In overcoming these limitations, the idea of applying hydroponic principle is employed. In efforts to ensure sufficient supplies to the market, 15 mother trees are made available as sources of tillers that is sufficient to produce some 3,000 stems. Tillers are extracted and stems are cut. These stems are then inserted into orifice prepared on polystyrene planks. These polystyrene planks then placed on waterbed with fresh filtered natural stream water. For ease of management, UPVC gutters are used to create waterbeds. Thus, there are range of these waterbeds supplied with continuous flow of filtered natural stream water. These waterbeds are placed on prepared based of measurements 50ft x 100ft concrete slab. This slab allows easy operations and maintenance. Over a period of two (2) weeks, having these stems subjected to the set condition under tropical conditions, young roots are noticed to start geminating while young leaves also start sprouting.

2. DISSEMINATION AND APPLICATION ABSTRACTS

2.1 DISSEMINATION AND TECHNOLOGY TRANSFER

Comprehensive Miniaturized Sewage Treatment Technology " Ecological Compound Micro-Circulation"

Ziyuan Feng Guangzhou Vetiver Eco-Science and Technique Co. Ltd. Guangzhou . China

Abstract

1. Miniaturizing sewage treatment technology is a worldwide challenge, especially in communities and rural areas where populations can be densely populated, land resources are scarce, and climates are different.

Land, facilities and maintenance costs are the greatest obstacle for miniaturizing sewage treatment technologies. Although the traditional sewage treatment technology varies, the process of miniaturizing the technology faces the challenges of insufficient treatment capacity, high treatment cost, and low treatment efficiency. Past research and the mechanisms involving the use of Vetiver Phytoremediation Technology (VPT) applications to treat sewage have resulted in many successful results. VPT is particularly important where land availability is a limiting factor. If VPT is combined with other technologies to form an ecological based "miniaturized sewage treatment" system, not only will construction and maintenance costs be reduced, but less land, will be needed. This miniaturized system is the basis of the "Ecological Compound Micro-Circulation " (ECM) wastewater treatment technology, and is another economic and practical method for using VPT to treat sewage. Its application is now being adopted in 5 provinces of China at an accelerated pace and the paper summarizes some specific examples for global application. Keywords: ECM, Vetiver Root System, Multiple Combinations, Clean Energy, Operating Costs, Water Quality Monitoring, Vetiver Phytoremediation Technology.

2. Vetiver Grass Operation According To The Royal Initiative At Huai Hong Khrai Royal Development Study Center, Doi Saket District, Chiang Mai Province

Suwimon Puttajunyawong1,3 , Thanongsak Parathai1 , Chackapong Chaiwong2 , Chaiphong Gavila3, ***1 Land Development Regional 6 office, Mae Rim District, Chiang Mai 50180, Thailand 2 Division of Soil Science, Faculty of Agricultural Production, Maejo University, San Sai District, Chiang Mai 50210 Thailand 3 Huai Hong Khrai Royal Development Study Center, Doi Saket District, Chiang Mai 50220 Thailand***

ABSTRACT

On February 24th, 1992, His Majesty King Bhumibol Adulyadej the Great and Her Royal Highness Princess Maha Chakri Sirindhorn cultivated vetiver grass in the experimental plot of Huai Hong Khrai Royal Development Study center (HHK RCSC) and the Royal Initiatives were given. The summaries of the Royal Initiatives were "...1) Cultivation vetiver grass would be helpful for soil and water conservation; 2) Studying and selecting the suitable vetiver grass according to the condition of the cultivated area; 3) cultivating vetiver grass at 3 months before rainy season in order to get the vigorous vetiver plant which could tolerate the power of runoff water in the rainy season; 4) cultivating vetiver grass in the channel and testing whether they could be used as the check dam." Throughout the 30-year period, HHK RDSC has operated the research according to the Royal initiatives which could be divided into 2 parts. The first part was a series of research program on effect of vetiver hedgerows on erosion, performance of each cultivar under different environment conditions and proper propagation technique. The second part was extension of vetiver grass cultivation for soil and water conservation and transferring of the knowledge related with vetiver grass. For promoting vetiver grass cultivation, HHK RDSC supported the farmers and the people who were interested in growing vetiver grass in their own areas or in the public areas such as the steep slopes along the way, the rims of farm ponds, the riverbanks, and agricultural fields. HHK RDSC produced 1,000,000 vetivers grass tillers per year and provided those tillers for further cultivation. There were 2 types of vetiver grass which were produced. Sri Lanka cultivar

was the lowland vetiver while Pang Kwang cultivar was the upland type. Thirty percent of the produced tillers were lowland type while those of the upland type were 70%. The vetiver tillers were produced as bare root tiller or tillers in nursery tray or tiller in nursery bag or tillers in a row or strip with the length of 1 meter, and the amount which were produced were 70, 15, 10 and 5% respectively. The survival rates of each type of vetiver tillers in the field after cultivation were < 50%, 75- 80%, > 90% and > 95% respectively. For knowledge transferring, there were 3 types, 1) Vetiver grass extension, 2) demonstration plot and 3) collection of vetiver grass cultivars in the field. The demonstration plots consisted of the use vetiver grass in agricultural areas, walking trail in the Dry Dipterocarp-Mixed Deciduous Forest where vetiver grass were

used for soil improvement and production of the suitable vetiver grass tillers according to the condition of producing area and environmental condition of the transplanted areas. In the plots where various cultivars of vetiver grass were collected and grown, 20 cultivars in 2 ecotype groups were lowland vetiver grass, and 19 cultivars were upland type. Under the field condition at 2 HHK RDSC, the upland vetiver grass had the better growth, higher survival rate, darker leaf color and more tiller numbers than the lowland ones.
Keywords: Huai Hong Khrai Royal Development Study Center, Vetiver grass extension.

3. Networking For Long Term National Vetiver System Development In China

Liyong Xu1 and Liyu Xu2 (China Vetiver Network, P.O. Box 821, Nanjing 210008, China;

Abstract

Vetiver System is a low cost and effective system which has been used for soil and water conservation, infrastructure protection, pollution control and treatment, and natural disaster prevention. It is over 20 years since it was introduced to China in 1988 through World Bank project titled Red Soil Development of China. The project covered 5 provinces in south China. To promote vetiver system to be developed more quickly and smoothly China Vetiver Network was established in 1996 supported by The Vetiver Network International and Chinese Academy of Sciences. Since then VS has been developed successfully in a long term. At first, VS was used for soil and water conservation of farmland. Since 1997 when Diti Hengchaovanich introduced his successful work on the use of VS for highway embankment protection during Fuzhou Conference, VS was started to be used for engineering protection and environmental protection（ Hengchaovanich, 1998）. Also since then VS research and application changed from research institution and universities to private companies. In the first decade VS was used in south China. In details, it was planted in the south of Yangtse River. Because soil erosion was proved very serious in north to Yangtse River, the Loess Plateau in particular, people did their best to move VS to north China, especially based on the climate change fact, i.e. the climate became warmer in the recent decades. At the same time China Vetiver Network insisted on the investigation and tests on Jiji Grass which has high tolerance to low temperature and drought since 1998. The paper reviewed how China Vetiver Network coordinate and promote national vetiver development from time to time in the past over 20 years. Multiple activities have been conducted such as: organizing conferences and training courses; coordinate and co-launching joint projects; produce and distribute various printed maters in large quantities; promote vetiver planting moving to cold area and continue test on drought and cold tolerant Jiji grass; establishing vetiver science popularizing garden and stimulating vs education among primary schools. Raising funds is very important for national networking. About 10 million of Chinese Yuan was raised in the period, which guaranteed various activities and projects to be conducted smoothly and successfully. Key words: network; China; conference, training, educatio

4. Applying Vetiver Systems In Transformation Of Slash And Burn Agriculture To Integrated Highaland Farming In Northern Thailand

Naphachart Karnthavong, Surachai Sitchoksaree, Natthawan Thampsuwan, Riw Pati-amornkit and Kesaraporn *Sreechun Highland Research and Development Institute (Public organization) 65 Suthep Road, Chiang Mai Thailand*

Abstract

Subsistence farming in Thai highlands depended on mono cropping that included slash and burn agriculture of upland rice, maize, intensive use of agro chemicals that leads to contamination in soil and water. The highland development program executed by Highland Research and Development Institute (HRDI) comprises of in searching for pioneer farmers, village profile mapping, extension of alternative crops and livestock with environmental friendly production and empowerment of farmers to be self-reliance. The case study in

Peepan Nue village in Omkoi District, Chiang Mai province is shown in the “big plot” with an area of 8 ha of 8 pioneer farmers whose farmlands are adjacent adopted integrated farming in replacement of uplands rice cultivated in slash and burn. Seven contours were manual made in 10-35% sloping lands with 810 metres in distance of each. In 2021, farmers and the officers jointly planted 50,000 vetivers (Mae Hae variety) along the contours and semi-circle shape around fruit trees. Mae Hae variety is known of rapid growth, high survival rate while its leaves are non-shapen. There was 80% of survival rate of one year old. In addition, local wood trees e.g. Fraxinus griffi thii C.B. Clarke and bamboo are planted for timber use, green house construction and firewood. Farmers are trained to be comprehensive of alternative perennial crops that appropriate in local geography and climate. e.g. coffee, avocado, peach, pear, persimmon and macadamia as well as soil and water conservation practices. Environmental-friendly production is a compulsory in integrated highland farming. In the sloping lands more than 50%, Arabica coffee is chosen for organic farming in the future. At the 10-35% of slope, persimmon and macadamia that require less intensive care is cultivated while less than 10% of slope, crops with intensive care of agronomy recommended for example avocado, peach and pear. Also, banana trees are planted in farms to nourish water, moisture and extra income. During the period that perennial crops cannot generate fruits or income, annual crops e.g. pepper chili, pumpkin, cabbage, kidney bean, konjac and black finger root are cultivate in space between fruit trees. This integrated farming cultivated in soil and water conservation systems has generated both immediate and long term food and increases cash income for farmers from US$ 285 to US$ 2,105 per year. Regarding soil fertility, organic matters increases by 0.50% while arsenic in soil reduces by 24.87 mg/kg. This has proven that vetiver system play vital role in heavy metal absorption. Applying vetiver systems in integrated farming in sloping agricultural lands generates both environmental restoration and sufficient economic return. Especially, vetiver systems has significantly contributed to soil and water conservation in sloping agricultural lands where life on highlands is restored and nourished. Farmers have better food security and income generated from integrated highland farming cultivated in water and soil convervation applying vetiver systems

5. Methodology Vetiver Handicrafts Projects In Venezuela Video

Oswaldo Luque Venezuela

Abstract

This methodology developed by the author of this video, shows how it was possible to train about 15,000 people formed by entire families, in the period from 2001 to 2019. The story begins in 2001 in Hogares Santa (10°13'30"N 68°16'06"N a house for the elderly people, located in Aguirre, Carabobo State. At that time, I was an advisor to the “Fundacion Empresas Polar" and I had to evaluate an agriculture project for these institutions. Commissioned to present a Project for low- income communities in the area. Professor Oscar Rodriguez of the Faculty of Agronomy, was a proponent of vetiver and gave me a technical bulletin N° 1999/1 tittle Vetiver Handicraft in Thailand. With this orientation we began to work with the vetiver handicrafts with both instructor Grace Rivero and Edgar Ceballos, later joined other instructors highlighting Marbella Rivas along with 19 others instructors who formed a large network of vetiver handicrafts. The Vetiver Polar Foundation Project lasted 5 years (2001-2006) with excellent results which were presented at the IV Conference on Vetiver held in Caracas. And his focus was to develop impoverished communities, control erosion problems, polluted water, and teach marketing techniques through expo-sales. There was a lot of interest in the subject, and other organizations were added; among them: Total Oil Co., “Carbones de la Guajira, C.A", Pepsi cola Venezuela, Agua Minalba to protect the springs and vetiver handicrafts for communities., Palmonagas, Bauxilum Los Pijiguaos, Vetiver Antierosion, where we work with 15 indigenous ethnic groups, and the pressure on a palm known as moriche (Mauritia flexuosa) was reduced, .which is a fundamental part of an ecological formation called “morichales", refuge of flora, fauna of the region, and source of crystalline waters. The natives to harvest the fiber, knocked down the plant or cut the apical bud

so that the plant dried, with notorious damage to environmental. Caribbean Ceramic Companies Group later consolidated a several vetiver projects in rural communities: Ceramics Plant in Chivacoa," Pavimentadora" Life in Barinas, Jose Antonio Paez General Military School. Truchicultura Moconoque a gave rise to the Labor Moconoque School. The latter group remained active until 2019. Several universities were also incorporated into the Project: Central University of Venezuela, Faculty of Agronomy, University of Los Andes- Faculty of Forest Sciences, Romulo Gallegos University, Simon Rodriguez University, and some units of the Venezuelan Ministry of the Environment, especially in the states of Barinas and Miranda. The Catholic Church has also actively participated, in the region of La Guaira-Miralejos sector, who created a group that marketed their vetiver handicraft at the International Airport of Maiquetia-Venezuela.

6. Vetiver System As An Action Plan For Agricultural Production And Infrastructure Reconstruction In Venezuela

R. Luque M. Vetiver Antierosion, C. A: Av. Circunvalacion N° 129 Pinonal Maracay ZP: Venezuela

Abstract:

This proposal was originally submitted to a commission of the Chamber of Deputies of Venezuela in 2019, which was elaborating a program for the reconstruction of the infrastructure of the country; however, due to the dynamics of the national political events, this has not been considered to date, although this does not mean that it has lost its validity, it is now more valid than ever, to the point that it could well be applied in any tropical or subtropical country, in line with the achievement of the Sustainable Development Goals (SDG 2030) of the United Nations Organization (UN) Presents national and international experiences in various areas of VS application, and raises the advisability of using them in Venezuela because of the contributions they can provide in the recovery of the deteriorated hydroelectric, hydrological, road and urban infrastructures. In the recharge of aquifers, in promoting agricultural production, in developing sustainable mining; in environmental resilience planning, and in addressing social problems. The simplicity of the VS, it's successful, verifiable, and replicable results, its low cost, its practicality, and its short implementation time make it a tool to consider for the recovery of the country's infrastructure and economy. During the last few years, little or nothing has been done to maintain the infrastructure at a functioning level that allows sustainable development. The few statistics published reveal a decline in areas where Venezuela was a reference of strength. The National Electrical System, based largely on hydroelectric generation; from being at the top of Latin American service, passed to the bottom. Among other elements, the cause of low generation is given by the decrease in water flow and the clogging of the vessels by sediments eroded in their basins, which leads to a decrease in the volumes of stored water. The system of dams for drinking water consumption or irrigation is contaminated by organic or agrochemical wastewater. The voracious and disproportionate mining exploitation in the region of the Venezuelan Amazon is causing great environmental liabilities. The production of agriculture is not capable of selfsustain the Venezuelan population. We have gone from being exporters of some items to the importation of 70% of the food that we consume. The high rates of extreme poverty have led to the largest diaspora in history, estimated at 20% of the population. A change of direction is necessary to face this situation, and the VS has a lot to contribute solving these problems. This proposal can be applied by planners from any country who wish to have a sustainable development.

7 Vetiver System Dissemination In Myanmar

Than Than Sein ***Myanmar Organic Growers and Producers Association***

ABSTRACT

Being an agricultural country, Myanmar is suffering the adverse effect of agochemical utilization including soil fertility degradation. Approximately two-thirds of the country's population is joining the agriculture

sector to earn a living from the land. As agriculture has been the backbone of the Myanmar economy and the largest population to be employed in the agro-sector. Serious deforestation because of the slash-and-burn agriculture system also created regional climate change, soil erosion, landslides, and flooding. At that time, a Myanmar scientist and maintenance engineer found a sustainable solution related to Vetiver grass. The vetiver system was introduced in Myanmar in 1996- 1999 with the FAO-UNDP project which was intended to protect the soil erosion in hilly regions of Southern Shan State. Myanmar engineers and scientists tried wide implementation again in 2014. To relieve the residual effect of agro-chemicals and sustainability of agroecosystem, Myanmar Organic Growers and Producers Association(MOGPA). Therefore, Myanmar Vetiver Network (MVN) was established and carried out the vetiver technology transferring activities collaboration with MOGPA. It could be a dynamic tool for mitigating environmental toxification and fertility degradation problems, thereby enhancing crop yield and supporting all- year round agricultural cultivation. Recently, vetiver grass has been used to raise animals , and relieve the heavy metal toxicity by phyto-remediation in integrated farming system. Key Words: Sustainability, Agro-eco system, environmental toxification, fertility degradation, phyto-remediation

8 Vetiver Grass: Community Use In Urban Areas In Lima, Peru

A. Kennerknecht, ALKE, Jiron Pisac 272, Surco, Lima, Peru A. Snyder, Calle Ocharan 600, Miraflores, Lima, Peru

Abstract:
As cities grow and the effects of climate change are increasingly prevalent, sustainable solutions to environmental problems in cities are vital. In Lima, Peru the company ALKE has been working to educate the public about the benefits of vetiver grass, and implement projects throughout Peru. ALKE works directly with communities on projects that support

urban farming, slope stabilization, and community beautification. ALKE has had widespread success promoting the vetiver system through its “1 to 3” system, in which groups are given one vetiver slip free of charge, contingent on the fact that these groups pass on three vetiver slips to other groups in the future. In five years, this system has succeeded in planting more than half a million slips throughout Peru, primarily concentrated in low-income communities. Keywords: urban, urban farming, community, education, climate change.

2.2 APPLICATION OF THE VETIVER SYSTEM

1. Establishment Of Vetiver Grass Nursery And Hedgerows For Control Of Eutrophication In Lake Victoria In Uganda.

I. K.Ahimbisibwe, Environmental Protection Information Centre (EPIC), P. O. Box 8762, Kampala, Uganda. **Abstract:**

Poverty and environmental degradation are inextricably linked never much so than around Lake Victoria, where both occur on a vast scale. That Lake Victoria is dying is not in doubt. A lethal cocktail of toxic waste and nutrients derived from industry, agriculture and urban centers is destroying the lake's ecology with grim consequences for 40 million people whose livelihoods depend on the lake directly or indirectly. Particularly serious is the process of eutrophication and water pollution caused by excessive nutrients especially phosphorous attached to soil particles. Eutrophication is associated with the growth and spread of Water Hyacinth weed (Eichhornia crassipes) an aggressive free floating weed. Decline of native fishery compels lakeside communities to engage in farming on fragile landscapes and on soils prone to erosion. They also burn charcoal and cut down trees for fuel wood. Ever more forest land is cleared for the needed firewood

and this additional deforestation increase the harmful runoff into the lake. In response, Environmental Protection Information Centre (EPIC) supports lake side communities to apply Vetiver Grass Technology (VGT) to control soil erosion where cultivation on unprotected land contributes to nutrient loading in the lake. The project established a Vetiver grass nursery to serve as a source of plant material for the entire community, trains farmers in application of Vetiver Grass Technology (VGT) and distributes Vetiver slips to farmers free of charge. It is envisaged that collaboration between EPIC and Food and Agriculture Organisation (FAO) will strengthen on-going efforts, fill gaps in extension services and scale up project activities through expansion of target area and extension of project life span to give ample time to Vetiver hedgerows to mature into effective natural barriers. The the project, plans to replicate VGT on the eastern side of Lake Victoria in Malaba River basin to address severe soil erosion. At Wanyange landing site on Lake Victoria in Uganda, 90% of sediment and pollution that used to flow into the lake is now blocked substantially by Vetiver barrier and has created a natural terrace. Protection of farmers' crop fields with Vetiver hedgerows curtails nutrient supply to Water Hyacinth Weed in the lake leading to its dearth. Control of the weed in some parts of the Lake has contributed to reduced incidences of malaria and Bilharzia whose vectors, mosquitoes and snails respectively, use water hyacinth weed as a breeding place. Aquatic life of plants and fish deep in the water has been revitalized through increased sunlight penetration and high concentrations of oxygen. Fish species previously thought extinct are recovering. Vetiver hedgerows block the flow of run off hence enhancing soil nutrients and moisture retention levels in crop fields. Farmers need not use fertilizers any more thus contributing to attainment of SDG 12. Protected watersheds are resilient to Climate Change shocks in the event of both prolonged draughts and heavy rainfall. Participants from target communities have equal say in matters related to the initiative, irrespective of gender, power status, wealthy and education. Keywords: Lake Victoria, Eutrophication, Water Hyacinth, Riparian communities

2. Vetiver Biofilter System (Vbs) Experiences In Control Of Soil And Water Contaminants In Industrial Operations In Venezuela. From 2001-2022

Oswaldo Luque. INVERSIONES LUQUE M. C.A. Residencias Portales de Shalimar, Urb. La Trigalena, Valencia Estado Carabobo, Venezuela.

Abstract

The Vetiver Biofilter System (VBS) is waste reclamation technique based on the incorporation of the Vetiver (Chrysapogon zizanioides (L) Nash) to the methodology called early as Biological Aeration Filter. There is a chapter that describes it in detail, technical, scientific aspects, construction and operation system, used at industrial areas in Venezuela. The VBS has been in uninterrupted operation for more than 23 years in some factories. It has been used for odor control, brewery sewage sludge processing, degradation of products not suitable for human and animals' consumption and their environmentally safe disposal, treatment of residual waters instead of Conventional water wasted treatment plant and recycling in agriculture of non-dangerous organic waste.

3. A Review On The Effectiveness Of Vetiver Grass Versus Other Plants In Phytoremediation Polluted Water And Contaminated Soil

N. Darajeh Faculty of Agriculture and Life Sciences Lincoln University, Lincoln 7647, Christchurch, New Zealand

Abstract

Increasing industrialization and higher standards of living have contributed significantly to a dramatic rise in global pollution in recent decades. This global increase occurs in both developed and developing countries, but more significantly in the latter. Vetiver System Technology (VST), which is based on Vetiver grass

(Chrysopogon zizanioides L. Roberty), has been successfully used to combat municipal wastewater such as sewage effluent, landfill leachate, urban runoff, drainage channels, etc., and also industrial wastewater from food processing factories, and runoff and byproducts from other manufacturing factories. In addition, VST is effective in treating contaminated mine overburden and tailings, solid waste dumps, industrial landfill, etc. due to its exceptional morphological and physiological characteristics. This review will concentrate on the treatment of polluted domestic and industrial wastewater by hydroponics and constructed wetlands treatment methods. Species selection is one of the most important factors to consider when conducting phytoremediation research, particularly when utilizing Constructed Wetlands. The ability of different wetland plant species to uptake and accumulate nutrients and heavy metals, as well as their effects on the structure and function of bacterial communities responsible for the removal of contaminants, are all highly variable. It is also necessary to consider the factors that affect the natural distribution of the selected plants both locally and within the region and locally, as these have a major impact on the successful establishment of the selected plants for phytoremediation purposes. Based on these and other factors, the following are some more important criteria used to select suitable wetland plants for the phytoremediation research project. The species of interest available/suitable for the proposed area Weediness potential of the plants of interest both within and outside the area The substrate preferred for the plants to grow in (sand, clay, mud, and peat) Aerobic and anaerobic conditions of the constructed wetland The depth of water suitable for the plants to grow in (shallow versus deep water) Wastewater contaminants in the wetland Comparing the use of various macrophytes to treat a wide variety of these polluted wastewaters, it was discovered that Vetiver grass is either equally or frequently more effective in treating these polluted wastewaters and contaminated land than 25 other plants, including other Vetiver genotypes and commonly used macrophytes such as various Cyperus species, various Phragmites species, and various Typha species. Vetiver has the potential to be used for additional purposes following phytoremediation, including as a raw material for handicrafts, essential oil and its derivatives, industrial products (raw material for pulp, biofuel, and paper), and fibreboard. In addition, vetiver is an ideal candidate for carbon sequestration due to its extensive and deep root system. Keywords: Vetiver Grass, Cyperus, Phragmites; Typha; Eichhornia; Schoenoplectus

4. Application Of The Vetiver System For Landfill Leachate Disposal In The United States

E. Wiediger, B. Granley, Leachate Management Specialists, LLC 10940 S. Parker Rd, Suite 776, Parker, CO USA

Abstract

Millions of tons of municipal solid waste are disposed in landfills every year in the United States. One of the most difficult and costly obligations for nearly all landfills is managing high volumes of leachate, which is generated when rainwater percolates through the waste and becomes contaminated with heavy metals, VOCs, ammonia, and other undesirable compounds. If not collected and treated, leachate contributes to polluted waters, causing major environmental and public health problems. Two of the most common management methods are hauling away in tanker trucks and thermal evaporation, but those options result in significant air pollution and CO2 emissions. Leachate Management Specialists (LMS) offer a nature-based alternative with its Phyto-utilization™ system which strategically leverage the morphological and physiological characteristics of vetiver grass. In 2011, a first-of-its-kind leachate disposal system in the country using vetiver was installed at an unlined, closed landfill in Mississippi. Leachate is processed through a fully automated pretreatment and distribution system before being pumped across a field of vetiver on top of the landfill through a drip irrigation network. The approach capitalizes on the natural ability of vetiver to utilize the components of leachate (moisture and various contaminants) as beneficial resources. Moisture is consumed due to vetiver's high evapotranspiration capacity and contaminants act as micro and macro nutrients to fuel plant growth. A system using vetiver also reduces infiltration into the landfill, resulting in

less leachate generation, further protecting groundwater and surface water resources. Vetiver is particularly well-suited for solving this problem due to other characteristics such as tolerance to harsh environmental conditions common of leachate and its root structure. Vetiver's carbon sequestration capacity and habitat development also make it an important tool to fight climate change and protect the environment. To date, LMS and its staff have overseen the planting of nearly 1,000,000 vetiver slips on over 15 hectares (37 acres) for irrigation of contaminated water within nine separate projects in the US and Mexico. US-based vetiver systems have consumed more than 78.4 million liters (20.7 million gallons) and millions more in Mexico. LMS is responsible for operation and maintenance of its vetiver systems, including remote monitoring, site visits, plant evaluation, sampling (leachate, soil, and foliar), flushing of irrigation tubing, and other activities. Additionally, LMS has successfully used the vetiver system to control a landfill leachate seep breakout. Since planting, the seep has disappeared, and the plants continue to grow well. As the concern of impacting our planet's water resources and climate change continues to grow stronger, more and more responsible entities are seeking sustainable solutions to reduce 2 their carbon footprint and environmental liability, and proudly face their community and investors to show that they are doing their part to mitigate these issues. An often quoted saying states that “pollution is just a resource out of place,” and nature-based systems such as PhytoUtilization™ using the vetiver system clearly accomplishes exactly this in the US by transforming a waste like leachate into an actual resource that fuels vetiver growth

5. Vetiver System: An Option To Consider In The Achievement Of The 2030 Sustainable Development Goals Of The United Nations Organization

R. Luque M. Vetiver Antierosion, C. A: Av. Circunvalacion N° 129 Pinonal Maracay ZP: Venezuela

Abstract

In the year 2015, with a favorable vote of 193 votes from the Member States, the United Nations Organization (UN) approved the execution of a 15 years plan that consists of 17 goals to achieve the sustainable development of humanity and the motherland; counting among others the end of poverty, the eradication of hunger, the improvement of health and well-being, sanitation, reliable water supply, the climate action, and the life of ecosystems. The Vetiver System, based on proven technological and social applications of the vetiver grass *(Chrysopogon zizanioides)* in more than
100 countries, can help, mitigate, and even resolve, 10 of the 17 objectives proposed by the UN; it includes one of most significant concerns of the international scientific community, as well as of the world population, the global warming of the planet. The present work will be developed on each one of the objectives proposed by this world organization; exposing, in the first instance, the problem as the UN visualizes it, and then the real possibilities of the VS, as a product of investigations of prestigious institutions and highlevel scientists, and verified in practice through multiple global experiences in tropical and subtropical countries. The simplicity of the technology, in whose application it is not required, in most cases, of a specialized human resource, together with the physiological and morphological properties of the vetiver plant, the ease of propagation and distribution in more than 100 countries; combined with the economic resources approved by governments of different countries, as well as by multilateral and bilateral organizations and NGOs available for the application of the plan, make this approach viable

6. Dissemination And Application Of V.S. On The Hawaiian Islands

J. B. Fox, P.O. Box 501 Papaikou HI 96781 USA,

Abstract

Vetiver Farms Hawai'i has developed and applied solutions, utilizing vetiver, that have had a significant and positive impact on communities and ecosystems in the state of Hawai'i. The Hawaiian Islands are subject to

heavy rains, earthquakes, landslides, shoreline and coastal cliff erosion. Our company sustainably propagates, installs and distributes vetiver grass for erosion control, bioremediation, phytoremediation, and water diversions. Our company has been developing and applying vetiver solutions for over a decade with well measured success. We have completed over 200 licensed contractor installations for residential and commercial properties, Hawai'i County and government facilities, a federal landfill and state parks. These vetiver applications range from shoreline erosion mitigation, ocean cliff stabilization and hillside stabilization. These applications have resulted in a 95% success rate and have contributed to bioremediation and sustainable infrastructure for all of Hawai'i. In addition to our licensed

contractor installations, we've created a large social media following and an online plant sale business that has allowed us to distribute an estimated 250,000+ vetiver plants since 2011. The success of our vetiver solutions was made apparent during hurricane Lane in August of 2018 and subsequent heavy earthquakes. The Big Island of Hawai'i received over 130 cm of rainfall, and many homes and businesses were lost to flooding and erosion. Every home, river and shoreline using our vetiver solutions survived this natural disaster, with 0% failures. Another example of measured success is the application of vetiver along coastal cliffside properties. After decades of erosion, many homes in Hawai'i are now situated dangerously close to the edge of oceanside cliffs. Our company has developed a solution utilizing vetiver that has significantly slowed erosion where applied. Our most concentrated application has been on the east side of the Big Island of Hawai'i, along a well-known beach named Honoli'i. We have planted 80% of the 3-mile residential stretch along this beach and shoreline with vetiver, while integrating *Paspalum vaginatum* on the edges of these 200-foot oceanside cliffs. Combining these species helped us successfully integrate vetiver's capabilities of subsurface water flow, soil cohesion and indigenous microorganism buildup that has brought longevity to these slowly eroding shorelines. Many of these installations are over a decade old. Old maps and aerial photos along with anecdotal evidence prior to installation, compared to our documented records after installation, prove the success of these applications. Our largest commercial planting in Hawai'i was for Waikoloa Plaza LLC, a large hotel and retail developer. This was the first large commercial planting in Hawaii, covering over 1,200 linear feet at a 55-degree grade. To our knowledge, we were the first company to disseminate and complete vetiver installation projects with the County of Hawaii and the federal government in the United States. We also utilized vetiver for a satellite stabilization project at the Pacific Missile Range, for the United States Navy on Kaua'i Island. In addition to stabilizing the satellites that protect the islands from north western hemisphere air attacks, we used vetiver grass to reforest their property with acacia koa. Unfortunately, we are not able to show images of this project. Our greatest achievement, through our 15-year journey with TVNI, has been the connections we have made around the world while disseminating the benefits of vetiver solutions. We trained the Tahitian highway department on design, implementation and capabilities of vetiver applications for highway stabilization. Most importantly, we have worked closely with Michael Cochran and the Meyah tribe of Papua Indonesia, and continue to support their sustainable infrastructure goals through selling their vetiver essential oil in the United States. In addition to selling many kilograms of the Meyah tribe's vetiver essential oil in the United States, we also distil our own high quality oil, from the high quality soil on our farm, spreading the word of the capabilities of this amazing plant through the sales of these products. We are passionate about providing sustainable vetiver solutions for the Islands of Hawai'i. We are grateful that our installations further support these islands by mitigating the amount of pollution that reaches the surrounding coral reefs. Our goal is to continue to leave a positive agricultural impact in today's developing world, through utilizing the amazing solutions that vetiver continues to offer.

7. Contribution Of Development Of The Vetiver System In Venezuela Since 2000 to 2023

Oswaldo Luque M, General Manager Inversiones Luque M Co.

ABSTRACT

The author has participated or promoted the development of vetiver several projects in Venezuela: Vetiver handicraft, phytoremediation, bioengineering, researches at universities and divulgation through newspaper, TV programs and conferences and webinars. Vetiver System Projects Several in Venezuela. Organizing Committee members of ICV-4 celebrated in Caracas in 2006. In the formation of Vetiver Antierosion Company initiated in 2001, as technical and research staff, especially in the application of vetiver for soil conservation and reclamation in Bauxite Mine. Project for use of vetiver handicraft for more than 15 indigenous communities who lived in the neighborhood of the mine. Participated in the use vetiver combined with trees to protect 40 hectares at Minalba Mineral Water Springs, to prevent erosion and water conservation. 3 Attended together with members of the Vetiver project of Fundacion Polar to International Training Course on Vetiver Handicraft in Bangkok, Thailand in 2005. Introduced the vetiver ecotypes collection from Khao Hin Son Royal Development Study Center from Thailand to Venezuela, contact with Faculty of Agronomy, Central University of Venezuela, to make studies around the country. The vetiver projects (2007-2019) to Caribe's Enterprise and their group, working with vetiver project in three different localities in Venezuela, focused on handicraft, to protect the land and water with vetiver barriers. Research to evaluate the adaptation of vetiver in Venezuelan Andes High Mountain to 2500 meters of sea level, and other item related with the personal development to poor people from Yaracuy, Lara and Merida States. Participated as the organizer of three Seminars together with Latin American Vetiver Network, Vetiver Antierosion Co, Andes University, Venezuelan Central University and "Ceramicas Caribe Co". Training Course for Indigenous People in Central Panama Republic, with participation of Vetiver Antierosion Ministry of Agriculture and Ministry of Environment of Panama in 2008. Design and directed the Vetiver Biofilter System to converted nonhazardous organic waste from beverages and food industrial plant in Venezuela, with excellent results. (2001-2022). Project in Alimentos Polar Chivacoa for Floating Vetiver Platforms wastewater treatment. Member of the movement clean waters for Valencia lake basin, to promoted a Mega Project, to treat wastewaters using VS. Problem affects more than 4,000,000 people. Vetiver Bioengineering project to protect Cuira's dam at Miranda state. Participated technical meetings in the Ministry of Environment of Venezuela, Miranda State, to help in the establishment of a Political forum in the area. Promoted the use of vetiver by teaching the communities on how to use VS for protection and stabilization large areas affected by very heavy rain in 2010. The conception of the video "the Vetiver, The Holy Plant", made by "Fundacion Empresas Polar, Tutor of thesis to research on the vetiver to treat contaminated water, and conducted research in the same item with Polar San Joaquin Brewery in Carabobo State. Recently 2022, promote community activities with vetiver to treat polluted water from small streams that later goes to Valencia lake basin. Promote community vetiver nurseries integrating environmental organizations. Consulter Newmont Co. at Surinam to use the VS to treatment water from their industrial process. Protected wells with VS in building to prevent contamination with 2 wastewater. Vetiver Landscaping in some public garden in the city. In summary, through my devotion and commitment in using VS for poverty alleviation, environmental protection, and climate change. (2000-2022). VS has been firmly established in Venezuela as a proven solution.

8. Outstanding Dissemination And Application Of The Vetiver System Application Of The Vetiver System

Komsan Koteseetha Operation Area: **Abstract**

Komsan Koteseetha previously growing a monoculture, mainly rice but he only grows during the rainy

season. During the dry season, the existing pond cannot hold water for other agricultural purposes which result in unemployment and no income after the farming season. Komsan Koteseetha had the initiative to transform his own rice field area into an integrated agricultural or new theory of agriculture after watching a television documentary about His Majesty King Rama IX's royal duties, in which he explained the concept of the Sufficiency Economy Philosophy. He divided his land to 30:30:30:10 by digging a new pond and water channel on his35 Rai area. He uses a levee to plant fruits and vegetables, but the soil is hard and dense and the area's shallow soil has laterite characteristics, making it unsuitable for growing fruits and vegetables because the plant's roots cannot reach the nutrition source. As a result, he came up with the idea of trying to grow vetiver grass to solve the soil problem. He requested vetiver grass from the Udonthani Land Development Station to try planting along the edge of the pond and the water channel to prevent erosion, and growing vetiver grass under vegetable and fruit trees to let the roots of easily penetrate for water and nutrients

3. PEOPLE PARTICIPATION

3.1 ON-FARM APPLICATIONS AND SOCIO-ECONOMIC IMPACTS

1. Farmer Participatory Uses Of Vetiver Grass In Highlands, Chiang Mai Province

Juraiporn KAEWTHIP1 , Ms.Anusara SOMSAK2 , Mr.Karn TRISOPHON3 , Mr.Thaworn MEECHAI4

Abstract

Since 1997, Vetiver grass was introduced under some part of the Royal Initiative as a “Grass that is beneficial to soil and water conservation because it has a root system that penetrate the soil vertically thus help holding water and stopping soil movement. The dense clump also helps trapping sediment and conserve top soil.” Vetiver was then perceived as benefiting the highlands, it had been grown in many patterns as hedge row along contour line, crop boundary, pond surrounding, fruit tree canopy surrounding and growing as semicircle in orchard areas. Vetiver leaf was also used as soil mulching and material to make compost in their own farm. Mr Phanom Chomphon who volunteered to work with office of Land Development Department Region 6 (LDD 6) had obtained knowledge on sustainable highland farming practices such as enhancing soil biodiversity and soil and water conservation practices for 26 years. Highland fields were particularly prone to erosion and losing of soil nutrient. In addition to filling up low-land water sources, if the evaluation was done by the amount of fertilizer loss per year, this must be tremendous. With this awareness in mind, Phanom had adopted vetiver hedge row as a measure against erosion. He also devotes a part of his farm as a multiplication plot and distributed the seedlings in his neighborhoods, actively helping LDD 6 extending the use of vetiver grass. Thirteen more farms covering 800 rais (128 ha) had adopted vetiver technologies both in their farms and along the village road shoulder. His dedication, determination and attentiveness made him a prominent player in vetiver extension program and he was recognized by various agencies. Mr.Phanom was awarded Golden Vetiver Award : Growing Promotion and Extension category from the contest in the 11th Vetiver Grass Using Campaign under the Royal Initiative Year 2018-2019. This awarded was granted to distinguish individual who actively using vetiver grass and promoting its usage. Eventhough this was the small spot of vetiver grass use, the power of distribution the knowledge of vetiver grass in the remote areas would certainly enhance sustainable farming in highlands for a long time. 1 Director, Technical for Land Development Group, Land Development Region Office 6 2 Chiangmai Land Development Station 3 Specialist on Highland Land Development, Land Development Region Office 6 4 Director, Land Development Region Office.

2. 'Conservation Marketing' The Case Of Vetiver Grass Technology (Vgt) In Ethiopia

Tessema Chekun Awoke, ***Addis Ababa, Ethiopia***

ABSTRACT

Choosing the strategies to mitigate land degradation in Ethiopia envisages sustenance of conservation interventions. Vetiver, a non-invasive grass with fast-growing tufted root system, is an ideal national candidate. Coffee Farmers' across the nation testimony almost the same, i.e. contour planting vetiver hedgerow was very efficient in soil conservation. When the grass hedges were established on sloppy farmlands, even on the first year, both annual runoff and soil loss were reduced by about 50% (farmers' observation). Farmers' also testimony that in addition to conserve soil and thereby increasing crop yield, vetiver pruning was used for coffee mulching, thatches, animal bedding and to some extent for animal feeding. Vetiver Grass in Ethiopia, particularly in coffee growing areas, was known since 1960's, but there are no evidences who and why it was introduced in the coffee farming system. Following the expansion of State owned Coffee Estates in the mid 1980's; Vetiver was planted as weed barrier, especially to halt the expansion of Coach Grass into the coffee farms. Based on this role, vetiver was nomenclature in Amharic1 as Yeserdo Sar Mekelakeya (Coach Grass Barrier). Systematic efforts to develop vetiver grass technology for soil and water conservation was first initiated by the Ex- Ministry of Coffee and Tea Development in the South West Coffee Growing areas in the early 1990's, taking cue from Thailand and Indian experiences. Vetiver Grass Technology was then extensively implemented as Hedgerows (Strips). Encouraging results were also recorded in halting soil erosion as well as in reducing water course pollution from wet coffee processing plants. But Menschen fur Menschen (MfM), a German Based NGO, taking cue from the MCTD initiatives, extensively implemented Vetiver system in the 'Illuababora Eco Development Program'. From 1990 to 2013, more than 7,500 hectares of farmland were treated with VGT. And about 5,000 farmers participated in enhancing VGT based farming system. VGT adapted well and protected the soil being eroded. Many NGOs taking cue from MfM, popularized VGT in their respective project areas. Vetiver Technology is now popular in all Regional States of Ethiopia. The effectiveness of VGT across the nation is on the rise and will ultimately inherent the throne as the core strategy for erosion control. Surprisingly a new theory 'Conservation Marketing' (i.e. Vetiver Clamp Sales) is emerging, which has already captured transactions. In year 2013 alone, farmers in Metu District of Illuababora Zone, generated about 1.2 million Birr (65,000 USD) through conservation marketing. Farmers who have adopted VGT are harvesting enough Clamps and generating net income on every treated farmland, while multiplication on their own nurseries offer them job opportunities and better income; raising their living standards. This paper therefore describes briefly the Vetiver Grass Technology and how it was developed, marketed, and networked in Ethiopia over the past 30 years.

3. Promoting And Dessimination Of Information About Vetiver System Technology Applications Across The South Pacific Islands

Robinson Vanoh. ***Founder/Managing Director - Eagle Vetiver Systems Ltd,***

ABSTRACT

The Small Island Developing States (SIDS) in the South Pacific are facing a possible catastrophic future due to the effects of climate change induced extreme weather events, these effects include a larger proportion of the most intense tropical cyclones, storm surges, droughts, changing precipitation patterns, sea-level rise, coral bleaching, and invasive species. Provision of inadequate social and basic needs services from a limited funded and poor government administration resulting amongst others serious food security and health problems, compounded by degenerating natural resources soils, forest and inland and coastal water. One part of the solution is the introducing of low cost, self-sustainable and relatively simple technologies that can help build resilient “do it yourself” Island communities. This project focused on disseminating information

about Vetiver System Technology (VST) for on-farm applications and socio-economic impacts of VST, and its role in protecting and sustaining the environment and hence enabling to empower the achievement of the Small Island Developing States (SIDS) Visions. Major problems of concern accelerating soil erosion and sediment transfer to rivers and coastal waters effecting food production, water quality, coastal fisheries/reefs, and tourism are its exploitation of its natural resources. Other problems such as wastewater, leachates and untreated sewage that negatively impacts on food security, infrastructure, human health, and coastal corals and fisheries; serious health and environmental issues linked to solid waste management are on the rise. The technical knowledge on the applications of VST is relatively new despite the Vetiver Grass being introduced into the SIDS back dating some 30 years in Papua New Guinea, Solomon Islands, Tonga, Cook Islands, Samoa and Vanuatu. In Fiji, it was introduced late in the last century by Indian migrant for thatching and medicinal purposes. This applicant introduced VST into the Atolls of Tuvalu in 2018 for the first time. Lessons learned will be further upscale to the other atolls in the country. The VST in the SIDS has the potential to reduce the impact of climate change which is very significant by the prevention and mitigation of natural disasters such as landslides, floods and extreme erosion. SIDS has multiple applications for environmental protection sector including; use for soil and water conservation, landfill waste management, riverbank stabilization, land protection and rehabilitation, stabilization of agricultural infrastructure such as roads, canals, drains and building sites. Keywords: Environment, Small Island Developing Nations; sustainability; climate change; erosion

4. **Vetiver Women Micro-Entrepreneurship: Building Resilience Through Mutually Benefited Interaction Between Nature And Local Community**.

Jacob Jose Manager, PDS Organic Spices, Valanjanganam, Kuttikkanam P.O, Idukki district, Kerala, India

Abstract:

Soil health is the foundation of agriculture, it boosts the resilience of farms and the supply chain to the effects of increased climate variability and healthy soils have a critical role as carbon sinks. Idukki district in the Western Ghats is facing severe soil erosion due to the top soil run off and loss of fertility. An NGO named Peermade Development Society (PDS), operating in Idukki district part of Western Ghats has been promoting the use of Vetiver grass, native to the Western Ghats to address the soil erosion problem the hilly tract of Idukki district. Vetiver grass (Chrysopogon zizanioides) due to its very deep and fibrous root system has the capacity to provide a natural means of soil conservation. This grass has the capacity to slow water runoff, tap sediments, filter out nutrients and retain soil. PDS encouraged the small farmers to plant Vetiver grass along the contours within the farms. The root of the Vertiver is used in the Ayurvedic and cosmetic industry for medicinal, flavouring and aromatic purposes. The leaves of Vetiver grow profusely but are left unutilized. PDS has trained a group of 50 home makers to make gift boxes using the leaves of the Vetiver plant, which enables them to make additional income for the household. This is one example of PDS's objective to ensure the sustainability of the ecosystem by transforming actions towards conservations to economic activity, a phase of Ecolo-Economisation. Thus an ecological activity is converted to an economic activity through women entrepreneurship whereby additional family income could be generated.

5. **Vetiver System For Rural Landscaping And Countryside Beautifying**

Hu Wenyou 1 , Xu Liyu 1 , Huang Biao 1 , Xia Hanping 2 , Xu Hairun 3 ***（1 Institute of Soil Science, Chinese Academy of Sciences, wyhu@issas.ac.cn; 2 South China Botanical Garden, Chinese Academy of Sciences; 3 Jiangsu Vocational College of Agriculture and Forestry.）***

Abstract

Early in 1988, the miracle grass vetiver was introduced to China for erosion control and agriculture

sustainable development. Later, it was extended to infrastructure stabilization and environmental protection. In the initial stage the development and extension of Vetiver System (VS) were mainly contributed to universities and research institutes. However, since 1999 numerous private companies have been established and played important roles in national economy development using VS. In the recent decades following national economy reform and open, Chinese government and people have become increasingly interested in rural landscaping and countryside beautifying, which is beneficial to tourism development. Vetiver can not only control soil erosion, fix slopes and banks, and reduce environmental pollution, but also strengthen landscape effects of outline of these natural items. As a result, it enables the countryside more beautiful, which attracts more urban people to travel in rural areas. There are many advantages for VS for rural landscaping and countryside beautifying: Vetiver grows very quickly and can configurate many desirable figures. As dense hedge, vetiver can strengthen natural scenic outlines and make countryside more beautiful. Vetiver can be pruned several times in a year to form desirable model and formation. Since vetiver can grow on soil and in water as well, therefore it can make land and water surface more attractive. Vetiver can generate different colors from green in the spring to red, brown and yellow when or after flowering in autumn, allowing countryside more colorful. Delightful ecological environment forms the most important item in beautiful countryside creation. It includes soil erosion control, flood and landslide reduction, pollution control, while most of these can be improved through proper VS interfering. Vetiver is easy to integrate into other plants, including different crops, grasses, trees, flowers, etc., making a beautiful landscape as a whole. Keywords: Rural landscaping; Beautiful countryside; Science popularization; Rural tourism; Vetiver System.

6. Application Of Vetiver Grass For Highland Environmentally Friendly Agricultural Development Planning, Nan Province

Naphachart Karnthavong, Arnat Thikhwan, Chawalit Sutthakhet, Moon Nonil and Pedcharada Yusuk, ***Highland Research and Development Institute (Public Organization), Suthap Road, Chiangmai 50200, Thailand***

Abstract

Thailand' Highlands are very important because there are sources of watershed, most of hill tribe communities are poor and without knowledge of occupation, grown monocropping especially maize and expansion of agricultural areas, these affected the environment. Nan is a province in northern of Thailand. There is third maize grown in country and 75% of the total agricultural area of the province, high use of agrochemicals, soil degradation from incineration, incorrectly land used, most of agriculture in sloping areas are cause of soil erosion more than 5 ton per 1 rai per year, bald mountain and smog pollution. Highland Research and Development Institute (Public Organization) as responsible for development Thai highlands to improve quality of life and environment by using the knowledge of Royal Project combining them with local and indigenous wisdom and knowledge lies on sustainable development by participation and environmental awareness plan. HRDI's development guidelines are 1) Finding Farmer leaders 2) Building faith and Leadership development for farmers 3) Surveying, integrating knowledge and analyzing communities on database 4) Planning for water development and management 5) Planning for soil Development 6) Planning for occupation development and 7) Developing Smart Farmers. HRDI base on the development of environmentally friendly agriculture in the highlands with focusing on people as the center of development and area-based development. Mr. Moon Nonil HRDI's Farmer in Sanian the Project using Royal Project System. HRDI's guidelines for development by managing of agricultural area of 26 rai, planning crop system, as a result, he has daily, monthly and yearly income. In the first year, he has net income 142,200 baht and 157,520 baht in the second year. He is able to release more than 70% of the informal debt and formal debt.

In addition, the application of vetiver grass in agricultural areas helps solving the problem of soil degradation from maize cultivation for a long time. In comparison of soil analysis, it was found that soil organic matter (OM) increased 1.80%, nitrogen (N) increased by 0.09%, phosphorus (P) increased by 11.9 (mg/kg), potassium (K) increased 4.48 (mg/kg) and almost Neutral pH. Including found that vetiver grass helps grow fruit trees in drought conditions. From the observation that tree fruit canopy grow larger and leaves are more green. The result of the development with the cooperation of farmers has increased the green area and reduced the burning in Nan Province.

7. The Green Latrine: A Low-Cost Sustainable Sanitation Solution For Rural Settlements (A Case Study Of A Pilot In A Household Setting In Busia, Kenya

E.M. Oyaro, N. Greene, H. B. Asfaw

Abstract

Globally, the majority of households lack adequate sanitation and this situation is worse in developing and rural economies. This lack of adequate sanitation solutions remains a widespread health and environmental hazard in many developing countries. Sanitation provision in most developing economies is predominantly on-site. There exists several technologies that are currently in use, each of varying affordability, suitability, adaptability and user satisfaction. These technologies include septic tanks, biogas latrines, composting or dehydrating toilets and pit latrines. Of these, pit latrines are the widely used form of improved sanitation solution. Of the 2.6 billion people using on-site sanitation worldwide, an estimated 1.6 billion use some form of pit latrine as their primary means of excreta disposal due to its simplicity of construction and ease of operation and maintenance (WHO, 2022)

8. Vetiver For The Welfare And Happiness Of The People

Dumrassiri, Thailand

Abstract

Three main lands for Geo-Socio-Econo area based development

1. Thongchai Rice Cradle In the district of Mueang Phetchaburi is the Thong Chai community. Agriculture is the main activity for people are mostly farmers.

2. Reforestation Nhongsaw Thayang Khao kra puk Community is in Tha Yang District, Phetchaburi Province. People are engaged in agriculture. Most of them are farming, growing vegetables, and kitchen gardens

3. Meung Petch Treasury. At the heart of the community, not far from Kaeng Krachan, applied the new theory practice for integrated sufficiency economy living.

9. Green Fuel Charcoal From Vetiver Grass And Mangosteen Peel

Omruedee Noopaen, Uthaiwan Panmanee and Chawisa Neranon

Abstract

80% of the fuels used in homes or in various establishments use natural fuels or use cooking gas for cooking. But natural gas is not enough to meet human needs in the future. In addition, the price of natural gas is much higher nowadays. many people, many departments must turn to look for fuel sources to replace natural gas to support human needs. Charcoal can be a secondary fuel source, but charcoal is made from wood, causing the destruction of the natural balance of the environment causing causing environmental problems, thus causing My group has invented and developed charcoal from the original wood. That

changed to vetiver grass and mangosteen peel. My group has therefore developed a fuel project from vetiver grass and mangosteen peels to use in various applications to reduce the use of natural gas to help build the community's economy. and reduce environmental problems as well

3.2 DISASTER MITIGATION OR ENVIRONMENTAL PROTECTION

1. Climate Risk Reduction And Soil Conservation Tool For Agriculture: Keyline Vetiver Hedges

Antonio Carrillo Bolea CEO Estampa Verde & Lead Designer 91581 Coatepec, Veracruz, Mexico

Abstract

Estampa Verde has been working with Keyline Scale of Permanence (P.A.Yeomans, Australia, 1958) and the Vetiver System in tropical areas of Mexico to provide an opensource technology for farmers that allows them to reduce climate risks and increase yields, capturing carbon through regenerative agricultural practices. The Keyline Vetiver Hedges provide a backbone and template for small (minimum 1 ha) and big farms (any size) that allows them to tap on the true productive potential of their farm under management. This paper provides the first version of a minimum standard for Keyline Vetiver Hedges, which is under continuous improvement and revision, and wishes to provide to the broader vetiver international community a set of steps forward to further collaborate and iterate versions of this suggested standardization. This minimum standard has been elaborated as one of the main projects for the Sustainable Tobacco Program in collaboration with Nueva Matacapan Tobaccos S.A., a very important cigar company in the Tuxtlas region that exports premium cigar wrapper to international tobacco companies worldwide.

2. Participation Of Asian Graduate Students For Geo-Information Project-Based Learning: Designing Analysis Framework Of Degraded Areas For Implementing Vetiver Grass To Support Restoration

Yaowaret Jantakatl , Pongpun Juntakut2 , Pradeep Kumar Shresth3 , Chomphak Jantakat4 and Vaneeporn Srisaal ***Department of Information and Communication Technology, Rajamangala University of Technology Isan, Nakhon Ratchasima, 30000 Thailand***

Abstract

This study proposed the designed framework of degraded areas' analyzing with implement of vetiver grass to support restoration using geo-information and technology. This research framework was designed by participation of 12 Asian graduate students (8 Thai people, 3 of Khmer people and 1

Nepali people). Based on a literature review and interviews with experts, implementation of vetiver grass in degraded areas of Nakhon Ratchasima, Thailand as a green supporting tool is analysed by project-based learning. They were assigned to design the research framework together under topics of research process steps such as identify the problem, evaluate the literature, create hypotheses and design research framework. The results were found that such 12- Asian graduate student can generate research framework of geo-information project-based learning in case of the designed research framework of degraded areas' analyzing with implement of vetiver grass to support restoration. Moreover, they can find answer for assignment of lecturer to design the research framework together under such topics above. Consequently, using this research project-based learning, lecturers and Asian graduate students have to develop or improve and learn how to use advanced geospatial technology for implementing multi-disciplinary.

3. The Final Report Of Rittiyawannalai 2 School, Following In The King's Footsteps According To Sustainable Development Goals

Rittiyawannalai 2 School ***The Secondary Educational Service Area Office Bangkok 2 Office of the Basic Education Commission Ministry of Education***

Abstract

Following in the King's Footsteps according to Sustainable Development Goals : SDGs to develop the school water ecosystem area. The Fiscal Year of 2021. The King's Philosophy., Academic Department, Rittiyawannalai 2 School. 16 pages. The purposes of this project are 1) to develop the school water ecosystem area. 2) to provide students a learning center about ecosystem with vetiver grass according to 2022 The King's Philosophy. The target group is a group of students learning about the development of ecosystem. The research Instruments are water quality tester, satisfaction survey form and learning diaries. Statistics used to analyze data are percentage, mean, standard deviation and scientific quality analysis of water ecosystem. The results shows that 1) scores of learning outcomes before and after learning about ecosystem for Matthayom 3 are different. The average score of learning outcomes before learning about ecosystem is 8.77 while the average score of learning outcomes after learning about ecosystem is 1 5.0 9 The difference between scores of learning outcomes before and after learning about ecosystem for Matthayom 3 is 6.31 The result of quality analysis of water quality is consisted of 1 . The color of water is brighter and water has no smell. 2 . Dissolved oxygen is better with more oxygen. 3. pH is lowered. 4. TDS is stronger with more solids and minerals. 5. EC is higher which indicates that there are more minerals in water. The results from satisfaction survey form towards the learning center of water ecosystem within school at water area in Rittiyawannalai 2 School are analyzed by mean, standard deviation and 5 ranking scale. The results indicate students' opinion at the highest. (mean 3.84 standard deviation 0.79) or 76.80%

4. Local Lover Project By Local Lover Project Lahansai Ratchadapisek School Lahansai District Lahansai District Buriram Secondary Educational Service Area Office Buriram

Abstract

The main problem is **s**tudents and young people nowadays lack of mental training. Therefore, the idea was to solve the problem by bringing nature and virtue to purify the minds of students and young people today to have love, unity, and cherish nature and the environment in order to create a network, and extending the results to the community It is a project created with the determination to encourage children and youth to learn about Dharma, nature and the nation, what is the way of life of the community and locality to develop creatively and knowledge of love and unity for peaceful coexistence. There is shame and fear of sin according to the principles of religion. taking into account the interests of the public and of the nation over their own interests Because Thai society is a society that is open to accepting things unknowingly due to lack of sufficient immunity to create participation and can be used in real life. knowledge of unity promotes sufficiency economy to be a person who thinks, acts, can solve problems by using the principles and live happily in society Continue to be a quality citizen of the nation.

Moral project about youth made to bring students to work together as a team, to develop the potential of students and youth, to develop desirable characteristics of learners in terms of morality and ethics by encouraging students to think, act, solve problems, and appreciate the value of the environment for students at Lahansai Ratchadapisek School and youth students in nearby areas. Students and youth in the provinces can learn and be self-reliant and coexist peacefully in a competitive society caused by people who lack social responsibility, lack of morality, and most importantly, people today lack mental refinement.

Therefore, the youth group established the Local Lover Project. Therefore, the idea was to solve the problem by bringing nature and virtue to purify the minds of people today to have love and cherish nature in the environment to create a network and expand the results to the community. Children and youth learn the culture that is the way of life of the community and the locality. can be self- reliant being dependent on others Sustainable resource management to develop creativity and knowledge of love and unity, create sustainable values for society and the nation, peaceful coexistence because Thai society is an open society that accepts things unwittingly because it lacks sufficient immunity to allow participation. and creative activities which is beneficial to society and the public can be applied in real life knowledge of unity and have a network cooperation in the sustainable development of society and the nation has brought students to participate in activities that are beneficial to the school. community and self promote sufficiency economy in order to instill morals and ethics in the students. StudeSnts can learn happily in school. When students have morals according to the sufficiency economy concept. It will make your study results better. and achieve the objectives of the national education curriculum that students are good, talented, happy, and able to live happily in society by using the principle performance It was found that students and youths had discipline, thoughtfulness, knowledge of doing things, better manners, respectfulness, and love and unity among the faculties within the school fence. different schools and schools in other provinces and able to be self-reliant