YUNNAN VETIVER NETWORK AND ITS CONTRIBUTIONS ON APPLICATION AND EXTENSION OF VETIVER SYSTEM

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Through technological exploration and engineering practices over the past 5 years, Yunnan Vetiver Network (YNV) was established by Kunming Zhongjiyuanchuang Technology Co. Ltd. in combination with Kunming Guangbao Biotechnology Engineering Co. Ltd. The former dominantly involves in vetiver seedlings production, mining rehabilitation, and industrial development and the latter involves in water ecological restoration and sewage treatment, production and marketing of microbiological materials, and engineering construction of ecological remediation and slope stabilization. The YVN studied and integrated a full set of technology system on vetiver seedling breeding and engineering design and its implementation and the comprehensive utilization of vetiver as a resource, furthermore, demonstrated project in Yunnan, Sichuan, Ningxia, and Gansu provinces, obtaining satisfactory results and positive market reaction. The YVN is trying to become technical facilitators or communicators of vetiver system in Yunnan and further in southwestern China. Followings are the chronicle of events for YVN.

1 Built up vetiver seedling production base to provide large quantity seedlings

There is a total territory area of 384,000 km^2 in Yunnan province, with 94% mountainous land of total area. Annual precipitation is about 1,109 mm with distinct dry and moist seasons, 90% of which happens in raining season (May-September). Thus, water and soil loss and even geological disasters such as landslip and debris flow take place frequently because of large mountainous area with steep slopes and concentrated rainfall. The demand to plant materials is getting more and more increasing when vetiver system is quickly applied in Yunnan province and southwestern China. Tremendous demand tends to be becoming the bottleneck of vetiver system application. Therefore, YVN was trying to expand the mass production of vetiver grass seedlings.

(1) A seedling propagation center with tissue cultivation with covering 500 m^2 was established in March, 2012 and realized the ability of cultivating 1 million seedlings/yr. Meanwhile, vetiver seedlings from several sites with different climate were collected, restructured and cultivated in order to cultivate and offer best seedlings (Photo 1 and 2).

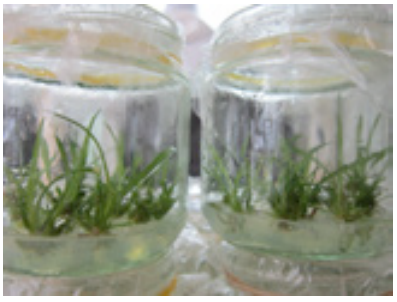

Photo 1 Tissue culture of vetiver in lab Photo 2 Tissue culture in greenhouse

(2) Seedling production bases of varying scales have been established in the field in Honghe,

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Baoshan, Chuxiong, and Wenshan of Yunnan province and Xichang and Wenchuan of Sichuan province with total area of more than 67 hectares. Over 100 million of seedlings are cultivated per year (Photo 3-5)

(3) Collaborated with China Construction Group, a vetiver production with the area of about 3 hectares was established in the Republic of Congo in 2012 (Photo 6-7), which laid foundation for the application and propagation of vetiver system in the country and even in Africa.

Photo 3 Nursery in Honghe

Photo 4 Nursery in Baoshan

Photo 5 Nursery in Chuxiong

Photo 6 Working in vetiver nursery

Photo 7 Watering vetiver seedlings

2 Experimental project and Demonstration implementation

The Yunnan Vetiver Network is getting increasing development from experimental projects to demonstration, promoting vigorously the application of vetiver system to different fields in Yunnan province and even Southwestern China, doing every effort for environmental protection and economic development in this region.

2.1 Actively participated in the Colorful Yunnan Protection Action

In 2007, the Colorful Yunnan Protection Action was totally initiated and implemented in the whole Yunnan province. The action slogan was “cleaner water, greener mountains, more blue sky, better resource protection, and more prominent biodiversity”. The YVN applied vetiver system to participate the action and carried out projects for ecological rehabilitation of quarry and mines such as gold, manganese, and copper, which has been a big problem for a long time as a mining province. The projects included followings:

- ✧ Ecological rehabilitation of open-pit mining area with 50 hectares in Jianshui manganese mining of Yunnan;
- ✧ Ecological rehabilitation of the quarry in Jiulongwan of Kunming city, and water and soil loss control of quarry in Luquan of Kunming city (over 100 hectares),
- ✧ Terraces protection in Yuanyang of Yunnan, a world heritage.

As a pioneer plant, vetiver has a well adaptation, grows quickly on the barren land, and improves the micro-climate environment so that growth of indigenous plants is promoted to contribute environmental amendment (photo 8-13).


Photo 8, 9 Before and after ecological rehabilitation of quarry in Lianmiansi, Panlong, Kunming City (From April, 2013-September, 2014)


Photo 10, 11 Before and after ecological rehabilitation of quarry in Jiulongwan, Panlong, Kunming City (From May 16, 2013-September, 2014)


Photo 12,13 Before and after Ecological rehabilitation of Liangmiansi Quarry, Longpan District of Kunming （April 2013-Sep.2014）

Meanwhile, vetiver system technology was applied to Sichuan province. In Xichang city, Sichuan province, the first-stage project on control of soil and water loss and ecological rehabilitation in Taihe mining field belonging to Chongqing Steel Group was conducted in June, 2012. The project restored the ecological system of bare hills with about 2.7 hectares in the mining field.

2.2 Application of vetiver system to poverty reduction

In addition, a comparison of protein content showed that fresh and tender Vetiver stems and leaves (at 65 days) was higher than alfalfa, clover, sweet potato vine and rice straw but slightly lower than that of Chinese milk vetch (*Astragalus sinicus*). Although protein content in dry Vetiver (at 65

and 215 days) was lower than alfalfa, it was higher than that in corn silage and other common winter fodders such as rice straw and wild oat straw. Moreover, the methionine content of Vetiver was almost the same as other fodders, while the lysine content was much higher. These measurements indicated that tender Vetiver grass clippings were suitable as fodder for cattle, sheep, pigs, rabbits, and fish. Also with cattle and sheep Vetiver seemed very palatable.

Thus, when vetiver is applied for water and soil control as a resistance to desert and drought and, fresh and dry shoot of fast-growing vetiver can be used to feed livestock so that it can improve farmers' income through developing animal husbandry.

From May, 2015, the YVN has applied vetiver system technology for the project of poverty reduction in Yunnan province, which met the provincial strategy of Vigorous Development of Mountainous Husbandry in Plateau Area and had vetiver grass become a good fodder source (Photo 14, 15). Local government plans to plant vetiver for about 7000 hectares along the basins of Jinsha River and Luzhi River. At the same time, in Chuxiong, Kunming, Honghe areas, the microbial strain GB1 that was developed by Kunming Guangbao Biotechnology Engineering Co. Ltd was applied to fermentation and production of high-quality fodders as a service to local domestic animal farms.

Photo 14 Vetiver is used to feed cattle

Photo 15 Vetiver is used to feed geese

2.3 Vetiver system for environmental governance and rehabilitation after earthquake disaster

The tensile strength of vetiver root system reaches 40-120 MPa (averaging 75 MPa) being equivalent to 1/6 of the ultimate tensile strength of common steel, it is greater than that of tree and bush root system. Meanwhile, vetiver root system has large soil contacting area and strong soil-fixing ability due to large numbers, net and deep plunging. So, the root system can play an enhanced role in fixing soil through strong tensile, frictional force, and adhesive ability. In April, 2011, the demonstration project of ecological rehabilitation and governance in Wenchuan earthquake disaster region was conducted under the support of forestry department of Wenchuan County in cooperation with University of Chinese Academy of Sciences. The total 3 hectares of slop distributed in 5 sites in Wenchuan and Lixian County were protected and rehabilitated. The effect appeared good so far and the technology was extended by local institutions. In 2013, local government carried out rehabilitation project along Minjiang river bank with total area of 20 hectares.

2.4 Vetiver system for the protection and ecological rehabilitation in hydro-power station construction sites

In combination of ecological rehabilitation in hydro-power station construction sites of Yunnan and Sichuan provinces, projects on broken hill governance and ecological rehabilitation in Dahua hydro-power stations of China Huaneng Group and Yazuihe hydro-power stations of China Resources in Sichuan province were implemented. These kinds of projects will be a main direction in the future.

2.5 Vetiver system for highway construction in Africa

During 2012-2013, under the collaboration of China State Construction Engineering Corporation, YVN applied vetiver system to the Republic of Congo (Photo 16, 17) and accomplished slope stabilization project to the National Highway No 1 (Photo 18, 19). With this success, YVN is going to

apply for the whole country and even Republic of the Sudan.

Photo 16 Vetiver grass seedling base in NKAYI

Photo 17 Training vetiver planting technology

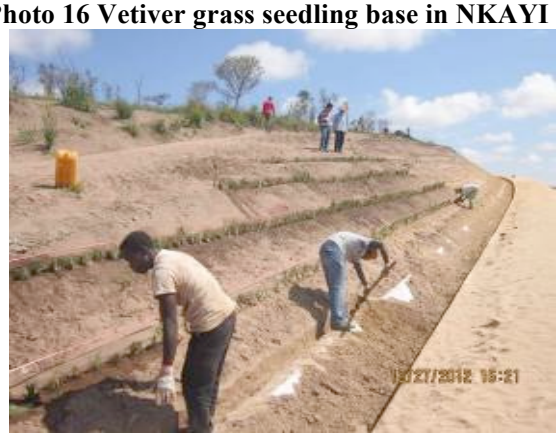

Photo 18, 19 Slope stabilization of National Highway No. 1, the Republic of Congo

2.6 Vetiver-agroforestry system

Vetiver grass grows rapidly and has large amount of biomass. Its height is able to grow up to more than 2 m after one season (5-6 month). Vetiver hedges planted in fruit and tea garden and slope cropland can be cut to obtain fresh shoot yield of 8-15kg/m^2 through 3-4 cuts. On the pure vetiver planting plot, 58-100t/ha of shoot and 24t/ha of roots can be harvested in. The vetiver hedges planted in commercial crops can effectively control water and soil loss and promote runoff to penetrate into underground, meanwhile soil organic matter and fertility can be improved. Thus, agro-economic benefit is increased and natural disaster can be reduced.

In cooperation with local agriculture, forestry, and animal husbandry institutions, the YVN interplanted vetiver with fruits trees and achieved soil and water retention improvement, insect protection and income increases. For examples, vetiver intercropped with:

- Grape in vineyard in Baixian County of Chuxiang,
- Coffee in Nujiang river valley of Baoshan,
- Pseudo-ginseng in pseudo-ginseng science and technology demonstration park of Wenshan,
- Paris polyphilla in Dali, and
- Apple in Fumin County.

In October, 2014, vetiver was also applied in orange plantation in order to control water and soil loss under citrus grove. These application extended influence of vetiver system.

2.7 Amelioration of stony and deserted soils

Vetiver system was applied in the project on amelioration of stony deserted soils in 2013-2014 in Xundian, Shilin, Gejiu, Yanshan counties of Yunnan province, which covered about 70 hectares and achieved the functions of retaining water and soil and preventing pest through intercropping.

At same time, in 2013-2014, vetiver system was extended to Lingwu county of Ningxia province and Minqin, Jingtai, Tongwei, Lintao counties of Gansu province in northwest China. Trials were conducted and seedling production base of 0.3 hectare was set up in each site (Photo 20, 21).

Photo 20 Vetiver system used to ameliorate saline soil in desert of Linwu counties in Ninxia (2012, left)
Photo 21 Demonstration of vetiver intercropping with Russian olive (June, 2012-December, 2013, right)

3 Deeply developed utilization and industrialization of vetiver resource

In latest a few years, besides the application of vetiver system to infrastructure protection, engineering and environmental protection, protection and prevention of natural disasters, and agroforstry, the YVN continually devoted to develop new products and technologies.

(1) Series products of vetiver were developed, including vetiver hydrolat (sold in market), series of edible fungi (Coprinus comatus, oyster mushroom, and needle mushroom), series of smoking mate and burning incense developed using the inherent sandalwood flavor of vetiver (Photo 22). The company has built up a workshops for the production.

Photo 22 Series products from vetiver

(2) In combination with animal husbandry institutions, the technologies on fodder production using vetiver shoot and leaf were mastered.

(3) Herb gardens with membership was proposed and organized in order to develop Plantation Economy and to propagandize the application of vetiver system. “Healthy breeding starting from the planting grass” was put forward and vetiver system was applied to in process of Industrialization of Mountainous Livestock Husbandry plateau Area. In addition, vetiver pastry series and fresh grass juice were developed.

(4) From 2011 to now, collaborated with Yunan Branch of Petro-China Kunlun Gas Co. Ltd, biogas was produced based on the characteristic of high content of C of vetiver. So far the mid-trial was finished.

(5) From 2011, the YVN attended the exhibitions hold by People’s Government of Yunnan Province and China Ministry of Science and Technology, Agricultural Exposition Kunming Pan-Asia International in 2012 and 2014. In the exhibitions, the application of vetiver system technology and series products were demonstrated and propagandized, which were paid attention to by officers, government and market.