

VETIVER SYSTEM APPLICATION AND EXTENSION FOR RURAL DEVELOPMENT IN THE MOUNTAINS OF SOUTHERN CHINA

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Abstract

Soil erosion has become a critical issue facing our global society. A total of 99.7% of the cropland is shrinking by more than 10 million hectares a year due to soil erosion. One rainstorm can wash away 1 mm of soil. It would take 13 tons of topsoil for one hectare – or 20 years, if left to natural processes, to replace that loss (Greenfield, 2010). As a result of erosion over the past 40 years, 30% of the world's arable land has become less productive. Because of the uncontrolled runoff there is insufficient potable water for world needs and this situation is getting worse, as a result of increasing population which aggrandizes the demand on land for more food, fiber and fuel, and aggravates rural environment.

Although there are many methods for soil erosion control, over a decade of experience has showed that vetiver grass is the ideal plant for soil and moisture conservation, embankment stabilization and environmental rehabilitation.

Keywords: Application, extension, handicraft, training, soil conservation

1. Introduction to Vetiver System development in China

A popular bioengineering option is vetiver (*Vetiveria zizanioides*) which is characterized by its strong stress tolerance, wide adaptability, quick growing vitality, huge biomass, highly developed root system with fantastic mechanical properties, and powerful soil binding capabilities. In addition, it is easy to plant, simple to manage and very low costs.

The miracle grass vetiver can play an important role in soil erosion control (Chen et al., 1994), land rehabilitation, earth work protections, etc. Over the past two decades, China Vetiver Network promoted the dissemination and extension of Vetiver Grass Technology (VGT) and Vetiver System (VS) throughout the country, through national information services; technology distribution via public media; organizing multiple conferences, workshops and training courses; operating joint field surveys and investigations; arranging demonstrations and bilateral visitations; distributing vetiver seedlings, training materials, mini-grants and awards, etc. (Xu, 2002a).

In addition, numerous bioengineering projects were implemented in China since 1999, which included vetiver grass, with its long and massive roots, for the embankment protection along highways (Xu et al., 2000; Xu, 2002b) and railways (Xu, 2003b), mine tailing re-vegetation (Fang et al., 2003), wastewater treatment, etc.

2. Vetiver-based Agroforestry for Erosion Control, High Quality Commercial Tree Production and Food Increase

2.1 Soil erosion in the project area

Due to increasing population and many other reasons, original forests were almost completely destroyed. In recent years following national economy reform in China, farmers and government officials have had increasing interest in clearing forests for commercial tree (economic forest) production, and have called it 'forestry revolution'. They cleared vegetation, built earth terraces and planted tea, mulberry tree, and chestnut, etc. on a large scale. Because this kind of cultivation lacked protection measures, it usually led to more soil erosion, resulting in the decline of soil fertility. Consequently, the commercial trees cannot grow well. In addition, the soil usually eroded away before commercial trees and new vegetation could grow up. As a result soil erosion aggravated sediment deposition in the reservoirs and the lower parts of river basins, and caused disastrous consequences.

In August 1975, for example, the dams of Banqiao Reservoir and Shimantan Reservoir, the two large reservoirs in the Dabie Mountains which covers an area of about 100,000 sq km, were destroyed by flooding. The beds of the reservoirs and rivers have risen by sediment deposits. The sediment was as high as the dams in 40 places in Jingzai County. As a result of the lack of vegetation cover, the ecosystem became worse and droughts frequently occurred. In 1978, for instance, there were 6 large reservoirs without any water input at all. The deteriorated environment aggravated poverty.

In 1998, the Dabie Mountains area suffered from serious flooding and landslides. For example, in Changpu Township of Yuexi County, there were 1600 houses in 420 families were destroyed. Meanwhile, of 8,179 Mu [1 hectare (ha) = 15 Mu] farmland there were 1,100 Mu (73 ha) of farm land that lost their harvest, with an economic loss of over 380,000 Yuan (about US\$45,000).

2.2 Vetiver-based agroforestry for commercial tree production

The sloping land with newly planted commercial trees may cause serious soil erosion in ecological fragile areas derived from granite, if the necessary protection measures are not provided. To solve this problem VS was introduced and vetiver grass was contour-planted as hedges at the edges of terraces and on sloping farmland to form Vetiver-based Agroforestry System (VBAF). The hedges can play an important role in erosion control and slope stabilization in just 3 months after planting. Cutting of vetiver grass was used as fodder for animals and as mulch for soil moisture and fertility maintenance.

In addition, other proper agroforestry technologies were introduced, demonstrated, and extended including: A-frame contour planting of crops and trees, living hedges of vetiver and multipurpose nitrogen-fixing shrubs for soil erosion control and soil reclamation, and intercropping crops in newly developed commercial trees to increase food production.

Since 2000 multiple VBAF projects were implemented in Guangxi and Anhui provinces respectively (Table 1). A total of over 2,250 Mu (150 ha) of commercial trees was protected and demonstrated by China Vetiver Network, which not only reduces soil erosion but also increases commercial tree production by 20% (Table 2).

2.3 Increasing food production and food self-sufficiency

In the Dabie Mountains, high-yielding fields only constituted 15% of the total farmland which led to food shortage. To increase food production, food crops were intercropped

with newly developed commercial trees to form the “commercial tree-vetiver hedge-food crop” system. In the meantime, intercropping can reduce bare land duration and increase land surface vegetation coverage, therefore reducing soil erosion.

Food crops such as wheat, beans, and peanuts, intercropped with young commercial trees under vetiver hedge protection can produce around 50 kg/Mu. In 2010, 100 Mu of tea bushes were planted in Changpu Township of Yuexi County under strictly prepared regulation. Investigations in 2013 showed that the bushes grew pretty well and started to generate profit, through careful pruning, manure applications, and proper tea-picking. In addition, food crops got an exciting harvest (Table 3).

Table 1. Vetiver-based agroforestry projects launched by China Vetiver Network (2007-2014)

Times	Project title	Commercial trees		Location of project
		Name	Area (Mu)	
2007,5-2009,4	Vetiver and Agroforestry Technology for Rural Poverty Alleviation and Natural Resource Protection in Minority Mountains of Guangxi Province of China	Peach + plum	100	Batan Village, Sishui Township of Longshen County, Guangxi
		Pear	160	
		Loquat	180	
		Peach + plum	100	Zhoujia Village, Sishui Township of Longshen County, Guangxi
		Pear	140	
		Loquat	120	
2009,5-2011,4	Vetiver Based Agroforestry for Poverty Alleviation and Soil Conservation in Dabie Mountains of China	Tea planting	100	Ganghe Village, Changpu Township of Yuexi County , Anhui Province
		Old tea reform	50	
		Bamboo	300	
		Tea	50	Shuifan Village, Changpu Township of Yuexi County , Anhui Province
2011,5-2013,4	Rural development and environmental protection in the Dabie Mountains of China	Bamboo	100	Ganghe Village, Changpu Township of Yuexi County , Anhui Province
		Oil tea camellia	250	Daifan Village, Shuanghe Township of Jinzhai County, Anhui Province
2013,5-2015,4	Rural development and soil erosion control in the Dabie Mountains of China	Bamboo	100	Zishi Village, Toutuo Township of Yuexi County, Anhui Province
		Tea planting	100	
		Old tea reform	100	
		Old tea reform	300	Daifan Village, Shuanghe Township of Jinzhai County, Anhui Province

15 Mu = 1 hectare (ha);

All projects were supported by Germany Economy & Technology Development Cooperation Ministry

Table 2. Income from loquat tree planting in Guangxi

Name of Farmer	Trees planted	Input/yr (Yuan)	Production		Input/yr (Yuan)	Production	
			Income (Yuan)	Years after planting		Income (Yuan)	Years after planting
Wei Wei	375	750.0	1,000	3	800.0	2,000.0	4
Yu Renxin	170	500.0	1,500	3	1,000.0	4,000.0	4
Huang Chunying	200	600.0	2,000	4	700.0	4,000.0	5
Qin Gaoyi	200	500.0	1,000	4	600.0	1,500.0	5

Table 3. Tea plantation production (Changpu of Yuexi County)

Year	Production of fresh tea leaves (kg)	Production value of tea (Yuan/Mu)	Intercropped maize (kg/Mu)	Production value of maize (Yuan/Mu)	Total production value (Yuan/Mu)
2010			200	500	500
2011			200	500	500
2012			150	375	375
2013	60	2,000-3,000	0		2,500
2014	120 (estimated)	4,000-5,000	0		4,500
2015	150 (estimated)	5,000-6,000	0		5,500

In addition, livestock such as goat and cattle and biogas facilities were also included in the projects with vetiver pruning as fodder and animal manure for biogas production.

3. Systematic Technical Training and Extension

Because the implemented area of the projects was limited while the Dabie Mountains is large, training and extension would be a critical measure to spread the VBAF experiences obtained from the project and should be a key component of the project, especially when the government did not put much fund for agricultural extension since the national economy reform a few decades ago. Observations and discussions revealed that there is a high enthusiasm among farmers who see training and extension as an important income generating opportunity.

3.1 Content of training and extension

Through discussion with experts, officials and farmers in and around the project site and other regions, the main contents usually included:

- ✚ The disastrous consequence of soil erosion and the importance of soil and water conservation;
- ✚ Reconstruction of eroded terrace and sloping land;
- ✚ The characteristics and growth habits of vetiver, its role and efficiency on conserving water and soil, and the technology of reproduction;
- ✚ Agroforestry technology that can increase farmers income, enhance food security and prevent soil erosion;
- ✚ The importance of plant and crop biodiversity;
- ✚ The planting technology of nitrogen fixation trees, bushes and crops, which can improve soil fertility and realize sustainable agriculture;
- ✚ Contour planting technology;
- ✚ Planting and management of commercial trees (bamboo and tea in particular);
- ✚ Multiple utilization of vetiver pruning.

3.2 Methods of training and extension

Method of training included:

- Regular training: Classroom lecture training combined with field practice.
- Self-study: Plenty of training materials were produced for free distribution to enable farmers to do self-study. Experts and technicians were arranged to give field

guidance. These materials gave a chance for farmers who cannot directly join the training to practice.

- Field visitation: Farmers are organized to visit nice demonstration plots and promote farmers to learn from each other. Sometimes, bad examples were also visited as a lesson.
- Extension was achieved through the production and wide dissemination of different training and extension materials.

3.3 Materials of training and extension

Many different training materials were produced for different people.

- Training manuals: Considering the local environment and social economic conditions, a specific training manual was compiled. The manual not only referred to the advanced technology but also better skills collected in the nearby region so that farmers are easy to accept them. In view of the lower education level of local farmers, pictures and photos were vividly included in the manual.

- Posters: Color posters that show farmers fundamental knowledge of sustainable farming were produced to let farmers put on the wall of their family room to enhance their memory.

- Newsletters (produced for 19 years since 1996 with 80 issues totaling over 24,000 copies) and Fact Sheets were produced in large quantities and distributed to both Dabie Mountains area and other regions in southern China.

- Internet and public media: The technologies and experiences were widely disseminated to the project site, the whole country and the world through internet and public media in order to enlarge the influence at home and abroad.

- Vetiver New Year's Greeting Cards: produced in large quantities and distributed to many different people during the Chinese New Year holiday called Spring Festival.

- Scientific books such as Vetiver Research and Development (1998), Vetiver System and Its Research and Applications in China (2003), and The Theory and Practice of Vetiver System (2008) were published and distributed to scientists nationwide.

3.4 Personnel of the training

The trainers were mainly the experts and the technicians who came from all over China, Anhui Province in particular. The duty of the experts was to compile training and extension materials, while well qualified local technicians and master farmers were invited to present lectures in order to settle out the difficulty of the dialect. Meanwhile, a supervision group was organized to give field guidance. Some experts were also invited to give special reports.

The trainees came from the project village, including local government officials. Farmers who directly accepted training consisted of about 400 for each project, most of them (about 70%) were women, and indirect trainees were expected to reach several thousand, mainly through large quantity dissemination of training materials.

4. Vetiver Handicraft Training to Enhance Women's Social and Economic Position and to Protect Rural Environment

In addition to being used to perform specific functions in soil and water conservation, environmental protection, etc., vetiver plants also have many other uses such as forage for

livestock, mulch, compost, nursery block / planting medium, animal feed stuff, mushroom cultivation, and botanical pesticides.

Of numerous uses, vetiver handicrafts have proved to be a most effective and attractive application in the use of grass leaves. Vetiver handicrafts have a huge significance and many advantages:

- ✧ Vetiver handicrafts can help poor farmers increase income without or with very little input and therefore improve their economic conditions dramatically. The only input is to plant vetiver grass at the edge of the terrace or on sloping land. The plants above ground can be used for handicrafts, while the roots can protect soil from erosion.
- ✧ Since the government issued a limitation for the applications of plastic bags, many city citizens reduced plastic use. However, in villages the plastic bags and other products are still commonly used by farmers because of their low price. As a result, the farming land has been increasingly polluted by plastic wastes (mainly plastic bags), while bags, baskets and containers made from vetiver grass are the best substitutes to replace plastic articles for farming and for family use.
- ✧ Several trainings in the past years indicated that women are particularly fond of learning and producing vetiver handicrafts. Once they grasp the skills they do not want to abandon them.
- ✧ Vetiver handicraft training and follow-up activities provide a good opportunity for women farmers to exchange technical and social opinions and ideas. In some places women established their own organization after the training called Vetiver Handicraft Cooperation Community that enhanced women's social and economic position.
- ✧ The former experiences showed that the training participants are fond of extending vetiver handicraft technology to their relatives, neighbors, and bordering villagers. Such an impact on the whole mountain regions will be far more significant than expected and will generate long-term effect in the mountains, perhaps for several generations.
- ✧ Vetiver handicraft cannot only help farmers reduce costs, but also can bring farmers a colorful life. Many farmers exhibit their handicrafts at their own homes to express their achievements, capabilities and assuredness. Meanwhile the local authorities, such as Village Committee or Township Governments in Anhui Province in the Dabie Mountains, require each participant to contribute a handicraft for exhibition purpose.

To sum up, vetiver handicrafts can promote vetiver planting for erosion control, reduce plastic applications, improve women's economic and social position, and protect the rural environment.

4.1 Experiences in vetiver handicraft training in China in recent years

To introduce vetiver handicraft technology to China the first training course was held in Longshen of Guanhxi Province in China in October 2007. Supported by Germany, The Vetiver Network International (TVNI), and the Royal Development Projects Board of Thailand, three Thai experts were invited as trainers to teach 20 Chinese minority women. The training course lasted 2 weeks.

The training course generated great impact in China and in the world. The event was widely disseminated by newspapers, TVs, and internets.

To spread vetiver handicraft techniques, further vetiver handicraft training courses were organized in Guangxi and Anhui Provinces respectively in 2009-2013 (Table 4). A total of 243 farmers participated in the courses, all being women but the 3 men.

Table 4. Vetiver handicraft training courses (2007-2013)

Number	Time	Location	No. of participants	Target and description
No. 1	22 Oct.-3 Nov. 2007	Lipai, GX	25	Introduce VHT into China
No. 2*	28-30 April 2009	Maluo, GX	36	Extend technology in GX
No. 3	22-28 Oct. 2009	Batan, GX	20	Improve skills and select trainers
No. 4	29 Oct.-11 Nov. 2009	Zhoujia, GX	24	Extend technology in GX
No. 5	16-29 Nov. 2009	Changpu, AH	22	Introduce technology to AH
No. 6	11-17 Oct. 2010	Shuifan, AH	20	Improve skills and foster trainers for further trainings in Anhui Province
No. 7	10-23 Oct. 2011	Dafan, AH	25	Introduce VHT to Jinzhai County
No. 8	24 Oct.-6 Nov. 2011	Ganghe, AH	20	Introduce VHT to Ganghe & Zhuangzhong villages
No. 9	8-13 Oct. 2013	Dafan, AH	27	Improve skills and select trainers
No. 10	16-29 Oct. 2013	Toutuo, AH	26	Introduce VHT to Toutuo township

GX = Guangxi Province; AH = Anhui Province; VHT= Vetiver Handicraft Technology; parti. = participants; *Organized by local government.

These trainings played an important role in vetiver handicraft technology extension. To recognize the achievements of outstanding farmers who did an excellent job in vetiver handicraft trainings TVNI released awards and certificates to eight farmers in Guangxi (2009) and Anhui (2012) provinces respectively (Tables 5 and 6). Additionally, trainees were selected based on their outstanding skills to receive prizes during each course.

Table 5. Vetiver handicraft award by The Vetiver Network International 2009

Awardees	Type of awards	Contributions
Mr. Bi Weijun	Technical excellence	- Training organization; - Model design and production; - Team leader of trainers for Anhui Province, 2009
Ms. Shi Lingyan	Technical excellence	- 2 nd award in vetiver handicraft training in 2007, - 1 st award in 2009 during 1 st training in Guangxi; - Trainer of training in April 2009 organized by local authorities; - Trainer for 2 nd training in Guangxi 2009
Ms. Wu Songlian	Vetiver handicraft	- 1 st award in vetiver handicraft training in 2007, - 2 nd award during 1 st training in Guangxi 2009 - Trainer for Anhui Province, 2009
Mr. Shi Xianzhou	Vetiver handicraft	- 3 rd award in vetiver handicraft training in 2007; - 3 rd award during 1 st training in Guangxi 2009; - Trainer for Anhui Province, 2009

Table 6. Vetiver handicraft awards by The Vetiver Network International 2012

Awardees	Type of awards	Contributions
Ye Naiquan	1 st Award	Organized the first vetiver handicraft training course in Jinzhai County of Anhui Province in October 2011. After the course he insisted in vetiver planting (vetiver hedges for erosion control and vetiver nursery). In addition, he established Vetiver Cooperative and led women actively involving in routine vetiver handicraft production. Organized Cooperative members to participate in Canton Fair, Agriculture Products Fair of Shanghai, and Agriculture Products Fair of Anhui Province with their handicraft products.
Xu Lixia	2 nd Award	Participated in the vetiver handicraft training course held in Changpu November 2009. After the training she insisted in vetiver handicraft production and grasped whole procedurals of the training. As the leader she led 3 trainers who attended the first vetiver handicraft training in Jinzhai County in October 2011.
Zhu Yingxiu	3 rd Award	Actively involved in the organization of vetiver handicraft production at Dafan village.
Zheng Dafang	3 rd Award	Produce different vetiver handicraft products in large quantities and helped others to study vetiver handicraft technology.

*All awardees come from Anhui Province

All of these trainings were organized very successfully. The experience showed that:

- There is a huge demand from farmers to learn vetiver handicraft because they take it as a very useful technology for making items for income generation, farming use and family use. Many farmers in nearby villages asked to participate in the training course and many local authorities hope to organize training courses in their area.
- Short time tests indicated that farmers can earn money from a few hundred Chinese Yuan to about 4,000 Yuan/yr with spare time by doing the work at home.
- A local tourism company contracted handicraft farmers to produce vetiver handicraft for souvenirs to send to tourists that bring farmers 1,000 Yuan/yr in average.

However, experience also showed some problems in vetiver handicraft development:

- Since vetiver handicraft technology needs a little longer time to learn it is not easy for farmers to grasp the skills without training.
- During initiation stage a little bit of support is needed to let participants initiate and develop the local market, in addition to vetiver handicraft training, because poor farmers find it very difficult to raise cash for such development.
- Although vetiver handicraft can have a long term influence on family economy it needs a little longer time for farmers to get profit because they have to pass several steps from a trainee to market developer, i.e. to grasp the handicraft skill, improve product quality, design and produce new products based on the local market, and then make products in large quantities.

- In poor and remote mountains the development is rather *fragile*, meaning it is influenced by many factors. For instance, a short distance of road reconstruction may affect tourism and vetiver handicraft sale for several years.

- The main products should be correctly selected and designed and should meet local culture or history. For example, small cucurbit was designed and produced in large quantities because its pronunciation is hulu” in Chinese, meaning ‘happiness’ and ‘high income.’ So people like it.

4.2 Structure of the training course

The course included two levels:

- (1) Primary Training Course lasted for 10-14 days; and
- (2) Advanced Training Course lasted for 6 days.

The content of the course includes:

- Key presentations introducing the main procedures for vetiver handicraft production,
 - Poster presentations on vetiver for soil erosion control,
 - Exhibition of handicraft products from former trainings,
 - Powerpoint and VCD performances,
 - Hand to hand practice and group discussions,
 - Exhibition and evaluation of trainees’ handicraft products,
 - Questionnaire and conclusion,
 - Final evaluation and awarding to best trainees,
 - Extended training by the trainees and thorough information distribution,
 - Distribution of vetiver planting materials to trainees for the continuation of handicraft production.

4.3 Time schedule for the training course

The program for the Primary Training Course should be:

Days 1-2: Opening ceremony and initiation:

- (1) Introduction to vetiver for soil erosion control and slope stabilization
- (2) Introduction to vetiver handicraft production
- (3) The preparation of vetiver leaves
 - Cutting of vetiver leaves
 - Selection of vetiver leaves
 - Boiling and drying of vetiver leaves
 - Dyeing vetiver leaves
- (4) Preparation of the models
- (5) General introduction on different models for boxes, hats, baskets, etc.

Days 3-8: Making of vetiver handicraft products

- Small boxes (2 days)
- Hats, bigger bags and baskets (2 days)
- Mat (1 day)
- Model making (1 day)

Day 9: Handicraft finishing and decorating

- Sulfur fuming
- Lacquer glazing

Day 10: Evaluation, selection and awarding to 6 most successful trainees; Closing ceremony.

The time schedule for the Advanced Training Course is similar to that of the Primary Training Course. The emphasis is put on new item design and work efficiency improvement. It, however, needs only 6 days. In addition, before the training a meeting was needed to discuss to arrange some details, which needs another 2 days.

4.4 Personnel

Three trainers were selected from former participants. A total of 20 women from the age 18-45 were selected as trainees in each course. As usual, more women than men participated in the trainings.

5. Project Evaluation

On request by donors, an external project evaluation was conducted. The main points focused on two aspects: economy and environment, i.e. if the projects brought farmers substantial benefits and if the projects implemented were environment-friendly. In detail:

- If the project components were designed based on farmers' needs and meeting local priority (nature priority in particular).
- If the project components were smoothly, economically and completely implemented.
- If the projects are beneficial to the local environment, or at least the components were implemented without harming the natural environment.
- If the projects can generate long-term effects, especially when the projects were finished.
- If the project has a huge impact.

The evaluators paid top attention to Relevance, Effectiveness, Efficiency, Impact, and Sustainability.

In addition, for each project component some criteria were prepared for by detailed evaluation. The success of the projects were fully approved and satisfied by evaluators (Cao, 2014). One of the most successful indications is that VBAF was extended and accepted by many different institutions countrywide.

6. Conclusion

Vetiver was found to be a miracle grass for use in agriculture since many years ago and should serve agriculture and farmers continuously. VBAF plus multiple trainings and extensions were proved to be an excellent measure for agricultural production and rural

development, which cannot only reduce soil erosion, but also help farmers, women in particular, get direct income and improve their social and economic position, protect rural environment and bring farmers a colorful life.

References

- Chen, K., Hu, G.J. and Rao, H.Q. 1994. Ecological effect of vetiver in orange trees planted on red soil slope land. *Acta Ecologica Sinica*, 14(3): 21-23. (In Chinese)
- Fang, C.J. and Zhang, G.F. 2003. Vetiver for revegetation on mine tailings. In: Xu, L.Y., Fang, C.J., Wan, M. (eds.): *Vetiver System and its Research and Applications in China*. HK: YaTai International Publishing Company Ltd., 71-76.
- Ling, C. and Yong, L. 2014. *Evaluation of the Vetiver Project: Rural development and environmental protection in the poor high mountains of China*.
- Xu, L.Y. 1996. Agroforestry technology extension in China. In: S. Sombatpanit, M.A. Zobisch, D.W. Sanders and M.G. Cook (eds.): *Soil Conservation Extension*. Bangkok: Soil and Water Conservation Society of Thailand: 199-206
- Xu, L.Y., Wan, M. and Peng, Y.S. 2000. The application of vetiver hedges for the protection of Shang-Fen highway in Jiangxi Province. *Journal of East China Highway*, 3: 65-66.
- Xu, L.Y. 2002a. The China Vetiver Network. *Proceedings of the Second International Conference on Vetiver: Vetiver and Environment*. Bangkok: Office of the Royal Development Projects Board: 200-208.
- Xu, L.Y. 2002b. Vetiver grass technology development and dissemination: From agriculture to engineering. *Proceedings of the Second International Conference on Vetiver: Vetiver and Environment*. Bangkok: Office of the Royal Development Projects Board: 200-208.
- Xu, L.Y. 2003a. Introduction to China vetiver and agroforestry project. *Proceedings of the Third International Conference on Vetiver and Exhibition*, Guangzhou, China. Beijing: China Agriculture Press: 255-261.
- Xu, L.Y. 2003b. The Vetiver System for railway embankment protection. In: Xu, L.Y., Fang, C.J. and Wang, M., (eds.): *Vetiver System and Its Research and Applications in China*. Hong Kong: Ya Tai International Publishing Company Ltd: 65-70.
- Xu, L.Y. 2004. Vetiver for sustainable watershed management in the Dabie Mountains. *Vetiverim*, 29: 18-19.
- Xu, L.Y. 2009. *Application and development of Vetiver System in China: 20 years experience retrospection*. PRVN Tech. Bull. No. 2009/2, ORDPB, Bangkok, Thailand: 1-28.