Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP2: 231-234

Sourav Gupta
SOA, ITM University, Gwalior, Madhya Pradesh, India

Sushil Yadav
SOA, ITM University, Gwalior, Madhya Pradesh, India

Brajraj Singh Kasana
SOA, ITM University, Gwalior, Madhya Pradesh, India

Ramnivas Sharma
SOA, ITM University, Gwalior, Madhya Pradesh, India

Correspondence
Sourav Gupta
SOA, ITM University, Gwalior, Madhya Pradesh, India

National Conference on Conservation Agriculture
(ITM University, Gwalior on 22-23 February, 2018)

Potential of Bamboo (*Dendrocalamus strictus*) Plantation for Sustain the Livelihood with Natural Resource Conservation in Chambal Ravine of Madhya Pradesh

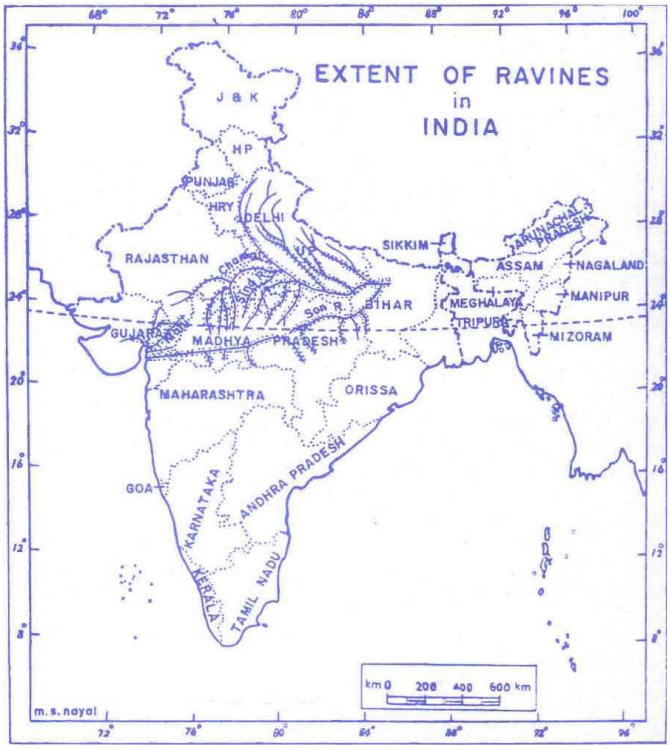
Sourav Gupta, Sushil Yadav, Brajraj Singh Kasana and Ramnivas Sharma

Abstract
Ravines have a variety of a gully net works and combinations with varying conditions of gully beds, gully side slopes, and gully intensities due to which no uniform and cost effective land development package can be made available or implemented till now and the problem remains as such. Rehabilitation of ravine lands with various kinds of vegetation not only provides livelihood support but also helps natural resources conservation and carbon sequestration in long run. Further the increase in vegetative cover in degraded ravine lands enhances the flora and fauna, and restores natural ecosystem thereby mitigating the impacts of climate change in addition to conservation of land and water resources for sustained productivity. Bamboo is known to be one of the fastest growing plants in the world, with a growth rate ranging from 30 to 100 cm per day in growing season. It can grow to a height of 36 m with diameter of 1-30 cm. India is one of the leading countries in the world in bamboo production. From bamboo plantation the additional employment average ` 10830 per hectare per year were received as labourer wages to the small and land less farmers for making secure livelihood. Through additional remunerative returns and generation of additional employment, bamboo plantation should sustain the livelihood security under Chambal ravine areas. However, there is a need to integrate the various stakeholders at various levels (production to consumption) for evolving workable strategies to promote these bamboo based interventions, which would not only be instrumental in addressing environmental concerns but also economic and livelihood security of habitants of these vulnerable lands.

Keywords: Bamboo plantation, Chambal ravines, Livelihood security, Net income

Introduction
Ravines are the network of gullies running parallel and discharging into river. India is having 3.67 m ha of ravine lands, which constitute 1.12% of total geographical area of 328 m ha (NCA, 1976). Very extensive degradation of land has occurred along some of the major river systems of the country in various states in the form of deep gullies. There are 4 major areas of severe ravine erosion on the map of India (Fig. 1). The largest is the Yamuna-Chambal Ravine Zone. The ravines flank the Yamuna river for nearly 250 km and in Agra and Etawah attain a depth of more than 80 m. Nearly 389,000 ha are affected along the Yamuna in southern Uttar Pradesh. The Chambal ravines flank the river Chambal in a 10 km wide belt, which extends south-west from the Yamuna confluence to 480 km to the town of Kota in Rajasthan.
The National Commission on Agriculture has repeatedly indicated that gullied lands not only create problems where they exist, but are also the root causes for degradation of adjacent arable lands affecting production potential in a major way. Most of the gullied and ravine lands are not inferior in their capabilities but are abandoned due to various other reasons. Ravines have been classified into small, medium, deep and narrow gullies; depending upon their depth, width and side slope in India.
Therefore, it has been suggested to necessarily retire ravine lands to permanent vegetation (Tejwani *et al.*, 1975) [19]. The small and medium gullies are reclaimed for cultivation safely while the deep and narrow gullies are recommended to be put under permanent vegetation of grasses and trees (Tejwani and Dhruva Narayana, 1960) [18]. Rao *et al.* (2013) [15]. Reported that stream bank erosion is a major cause of land degradation, leading to deteriorated drainage

systems, which ultimately govern natural calamities in terms of floods and nonpoint source pollution in ravine lands of India.



(***Source*:** V.V. Dhruvanarayana, 1993)

Fig 1: Extent of ravine lands in India

The inclement weather conditions coupled with very high summer temperature further aggravates the problem and makes farming uneconomical. In such situations, less water and nutrient demanding technologies hold a good promise to sustain the productivity and provide alternative source of income to the farmers. This vast tract of existing ravine lands poses potential threat to nearby productive lands because of over-exploitation and poor management. Therefore, there is an urgent need to arrest degradation of these lands and protect both the arable and non-arable lands from further degradation.

With about 22 genera and 130 species, India is the second largest reservoir of bamboos, next only to China (Nath *et al.* 2009) [10]. India's share in the global bamboo market is estimated to be of US $1 billion and is expected to increase to US $5.7 billion by 2015 (Omari, 2009).

India today exploits only one-tenth of its bamboo-producing potential. Of nearly 130 species, only about 10 are being commercially exploited. These are: *Bambusa arundinacea, Bambusa affinis, Bambusa balcooa, Bambusa tulda, Dendrocalamus strictus, Dendrocalamus hamiltoni, Dendrocalamus asper, Oxytenanthera stocksii* and *O. travancorica*. Among these species, *Dendrocalamus strictus* has been found quite promising in the ravine lands. This has been tested for protecting severely eroded gullies of ravine class VI and VII lands1 with promising production potential (Dhruva Narayana, 1993) [5].

Bamboo is well suited to polycyclic harvesting; it can be grown on steep hillsides and along the banks of rivers. Its interlocking root system and leaf deposit inhibit soil erosion. Production of bamboo is reported to improve with the age of plantation, though the percentage of new to old culms decline with age. Harvesting of bamboo is started after 7 years with 10 old and 3 new culms available per clump in the ravine land (Dhruva Narayana, 1993) [5]. In addition, benefits of living biomass and soil organic matter content in bamboo stands have been well reported (Lin *et al.* 2004; Tong, 2007) [8].

Impacts of bamboo planting include raised groundwater level, increased land productivity, improved micro-climate and improved socio-economic conditions. Bamboo is so fast-growing that it can yield 20 times more timber than trees on the same area (http://life.gaiam.com/article/how-eco-friendly-bamboo, accessed 19 December, 2011).

It is also seen that bamboo-based Agro-forestry models improve ecological parameters of a highly degraded basaltic tract of Jabalpur, Madhya Pradesh (Behari *et al.* 2000) [2]. Similarly; Bahadur *et al.* (1980) [1]. Reported that improved farm practices and land treatment by bamboo, grasses and legumes on bunds, sloppy lands and terraced lands have been found to be effective means of soil and water conservation..

Keeping the above facts in mind, the present study was undertaken to find out the potential of bamboo cultivation for ravine land reclamation, livelihood security and generation of additional income from waste/degraded lands.

Study Area:

The study was done on ravine lands of Chambal command area (Table 1) in Madhya Pradesh.

Table 1: Details of the study sites

Details	Chambal ravine
Latitude,	22°27′ N to 26°29′ N
Longitude	75°31′ E to 79°15′ E
Rainfall (mm)	787
Temperature range (°C)	7.5 to 38.2
Vegetation	Tropical ravine thorn forest

Source: Wikipedia

Rehabilitation of ravine lands with various kinds of vegetation not only provides livelihood support but also helps natural resource conservation in long run. Further the increase in vegetative cover in degraded ravine lands enhances the flora and fauna and restores natural ecosystem; thereby mitigating the impacts of climate change in addition to conservation of land and water resources for sustained productivity.

Researchers have clearly established the importance of bamboo plant as an effective means for natural resource conservation. Various research findings have reported positive utility of bamboo plantation for enhancing natural resource conservation (Lawler, 1993; Yanhui *et al*. 1995) [7,21]. Zhou *et al*. (2005) [22]. reported that soil erosion was low in bamboo plot (178.15 kg/ha) as against other forest plantation types. The characteristics of bamboo plant make it a perfect solution for the environment and social consequences of tropical deforestation. Its biological characteristics make it a perfect tool for solving many environmental problems such as; erosion control. On account of extensive rhizome-root system and accumulation of leaf mulch, bamboo serves as an efficient agent in preventing soil erosion, conserving moisture, reinforcement of embankments and drainage channels etc.

Bamboo generates plenty of oxygen, lowers light intensity and protects against ultra violet irradiations and is an atmospheric and soil purifier. The increased permeability of the soil reduces surface run-off, evaporation loss, allows better water penetration into the soil and increases drainage capacity of the soil. Sharma *et al.* (1992) [17]. Have also reported that bamboo conserves soil moisture and mitigates the adverse effects of drought on flora and fauna. Bamboo as Agro-forestry system was evaluated and found quite encouraging (Shanmughavel and Francis, 2001; Deng *et al.*

2003; Jha and Lalnunmawia, 2004; Nath and Krishnamurthy, 2008) [16, 4, 6, 11].

Average ranges of annual interception and stem flow in bamboo plantations have been reported as 13 - 15% and 4 - 6%, respectively (Lu SY *et al.* 2007) [9]. Which looks a bit higher than those under natural hard-wood forests due to special canopy characteristics. The comparatively dense foliage protects against beating action of rain drops and its habit of producing new culms from underground rhizomes allows harvesting without disturbing the soil (Ben-zhi *et al.* 2005) [3, 22]. Pande *et al.* (2012) [14]. Found bamboo plantation economically viable in ravines and suggested policy measures to development agencies and finance institutions for large greening of ravines in the country.

Cost of cultivation for bamboo plantation under Chambal ravines in Madhya Pradesh

Table 2: Unit cost for raising 1 hectare bamboo plantation in Chambal ravine land (On the basis of 2010-11 prices)

Items	I year	II year	III year	IV year	V year	VI year	VII year	Total
Material								
Planting material including 20 per cent mortality replacement in second and third year	2000	200	200	-	-	-	-	2400
Manure and fertilizers (DAP) (50 g/plant)	190	-	-	-	-	-	-	190
Plant protection (LS*)	600	-	-	-	-	-	-	600
Irrigations, 8 No. (` 800 per irrigation)	6400	6400	6400	6400	-	-	-	25600
Sub-total	9190	6600	6600	6400	-	-	-	**28790**
Labourer (mandays)								
Land preparation (LS*)	6000	-	-	-	-	-	-	6000
Digging of trench, refilling @ ` 45 per trench (400 No.)	18000	-	-	-	-	-	-	18000
Planting and staking (400 No.)	2800	280	280	-	-	-	-	3360
Soil working and others (2)	-	3600	3600	3600	3600	3600	3600	21600
Watch & ward (LS*)	3000	3000	3000	3000	3000	3000	3000	21000
Harvesting - 7th year onwards	-	-	-	-	-	-	6000	6000
Sub-total	**29800**	**6880**	**6880**	**6600**	**3600**	**3000**	**9000**	**75960**
Contingency (5%)	1490	344	344	330	180	150	450	3798
Grand total	**40480**	**13824**	**13824**	**13330**	**3780**	**3150**	**9450**	**108548**

*LS - Lump sum (***Sourse:*** Pande *et al*., 2012)

Land preparation before bamboo plantation in ravines was required to remove obnoxious weeds which compete for moisture otherwise would raise the expenditure on irrigation. The expenditure on establishment items was spread over a period of seven years. Only protection and harvest costs would occur beyond that period. The major expenditures were occurred during the initial four years, while only the minor costs are spread over the subsequent years.

The total cost on production of bamboo during seven years was about ` 108548/ha. The main expenditure of bamboo plantation is occurred during the I$^{st}$ year of plantation i.e., ` 40480/ha, which was reduced by every year after plantation. The maximum labourer cost was occur during the first year i.e., 29800/ha. During the subsequent years, the labourer wages were also reduced (Table 2). The labourer wages were increased further after sixth year; when the harvesting of the bamboo plants should started.

Expected outcome through bamboo Cultivation

The harvesting of bamboo plant was started in seventh year of plantation. The expected out come from the bamboo cultivation under ravine lands was about 1200 bamboo poles/ha, which gave about ` 28950/ha net income to farmers during the VII$^{th}$ year of plantation. Similarly, about 1200 bamboo poles/ha yielded during VIII to X$^{th}$ year of plantation, which gave about ` 29400/ha net income (Table 3). After the Xth year the bamboo plantation produced about 1600 bamboo poles/ha and gave about ` 41400/ha net income to the farmers.

Table 3: Expected yield and net income by bamboo plantations in Chambal ravine systems

Years	Yield (number of bamboo poles/ha)	Net income (`/ha)
VII	1200	28950
VIII to X	1200	29400
XI year on wards	1600	41400

Source: Pande *et al.* (2012)

Expected additional employment generation through bamboo plantation in Chambal ravine land area:

From bamboo cultivation under ravine lands of Chambal River in Madhya Pradesh makeup remunerative returns with several possibilities to increase additional employment for small and poor formers of the region. Through bamboo plantation; the 248 labourer mandays were generated during the first year. Subsequently, during second to sixth year average 55 labourer mandays per year were generated. During the seventh year onwards approximately 100-110 labourer mandays were generated under bamboo plantation. From bamboo plantation the additional employment average ` 10830 per hectare per year were received as labourer wages to the small and land less farmers for making secure livelihood (Table 4). Through additional remunerative returns and generation of additional employment, bamboo plantation should sustain the livelihood security under Chambal ravine areas.

Table 4: Additional employment (labourer mandays) generation by Bamboo plantation in Chambal ravine (On the basis of 2010-11 prices)

Items	I year	II year	III year	IV year	V year	VI year	VII year	Total
Land preparation (LS*)	50	-	-	-	-	-	-	**50**
Digging of trench, refilling @ ` 45 per trench (400 No.)	150	-	-	-	-	-	-	**150**
Planting and staking (400 No.)	23	2	2	-	-	-	-	**27**
Soil working and others (2)	-	30	30	30	30	30	30	**180**
Watch & ward (LS*)	25	25	25	25	25	25	25	**175**
Harvesting - 7th year onwards	-	-	-	-	-	-	50	**50**
Total	**248**	**57**	**57**	**55**	**55**	**55**	**105**	**632**

*LS - Lump sum

Conclusions

Deep and narrow gullies are recommended to be brought under permanent vegetation of grasses and trees. Bamboo plantation for productive and protective utilization of such degraded lands is not only a profitable option for local stakeholders but also an economically viable policy option for funding agencies and government and non-government agencies. The bamboo harvest cycle would continue for a long time in ravines if a recommended practice of harvesting one-third culms per clump is followed.

The wasteland development programme of the government would be an appropriate mechanism to address this problem. It is suggested that high cost of establishment could be met through financial incentives to the group/village community on a collective basis and such policy instruments can be converged with land base schemes of central and state governments like; MGNREGA or some other similar schemes. The large-scale bamboo plantation could be undertaken with assistance from such schemes and the remaining cost of plantation could be paid by the group/village society towards environmental services provided by the locational bamboo ecosystems.

References

1. Bahadur P, Chandra S, Gupta DK. Hydrological studies on experimental basins in the Himalayan region, the influence of man on the hydrological regime with special reference to representative and experimental basins, Symposium-IAHS-AISH Publ. 1980, 130.
2. Behari B, Agarwal R, Singh AK, Banerjee SK. Vegetation development in a degraded area under bamboo based agroforestry system. Indian Forest. 2000; 126(7):710-720.
3. Ben-zhi Z, Fu Mao-yi, Xie Jin-zhong, Yang Xiao-sheng, Li Zheng-cai. Ecological Functions of Bamboo Forest: Research and Application. Journal of Forestry Research. 2005; 16(2):143-147.
4. Deng Y, Yan Peng, Yukuan Wang, Zongling Yang. Soil Conservation Efficiency of Different Models Converting from Steep farming Slope Plots in ya'an, Schian, China. International Journal of Sediment Research. 2003; 18(4):340-345.
5. Dhruva Narayana VV. *Soil and Water Conservation Research in India*. Indian Council of Agricultural Research, Krishi Anushandhan Bhavan, Pusa, New Delhi, 1993.
6. Jha LK, Lalnunmawia F. Agroforestry with bamboo and ginger to rehabilitate degraded areas in north east India. Journal of Bamboo and Rattan. 2004; 2(2):103-109.
7. Lawler DM. The measurement of river bank erosion & lateral channel change: A review. Earth Surface Processes and Landforms 1993; 18:777-821.
8. Lin Xinchun, Fang Wei, Li Xianhai, Zhou Changping, Zhong Xiaofeng, Hu Chaozong. A study on biomass structure of *Pleioblastus amarus* population. Journal of Bamboo Research. 2004; 23(2):27-29.
9. Lu SY, Liu CP, Hwang LS, Wang CH. Hydrological characteristics of a makino bamboo woodland in Central Taiwan. Taiwan Journal for Science. 2007; 22(1):81-93.
10. Nath AN, Das G, Das AK. Above ground standing biomass and carbon storage in village bamboos in North East India. Biomass and Bioenergy. 2009; 33:1188-1196.
11. Nath S, Krishnamurthy R. Nutrient cycling in plantation stands under laterite soils of South West Bengal, India, Proc. International Conference on Improvement of Bamboo Productivity & Marketing for Sustainable livelihood, New Delhi, 2008.
12. National Commission on Agriculture. Report of National Commission on Agriculture, Part 5: Resource Development, Govt of India, New Delhi. 1976, 107-322.
13. Omari MP. A Cost-Benefit Analysis of Substituting Bamboo for Tobacco: A Case Study of South Nyanza, Kenya, M.Sc. Thesis submitted to University of Nairobi, 2009.
14. Pande VC, Kurothe RS, Rao BK, Gopal Kumar, Parandiyal AK, Singh AK, *et al*. Economic Analysis of Bamboo Plantation in Three Major Ravine Systems of India. Agricultural Economics Research Review. 2012; 25(1):49-59.
15. Rao BK, Gaur ML, Kumar G, Kurothe RS, Tiwari SP. Morphological characterization and alterations in cross section of different order streams of Mahi Ravines. Indian J Soil Conserv. 2013; 41(1):20-24.
16. Shanmughavel P, Francis K. Intercropping trials of four crops in plantations. Journal of Bamboo and Rattan. 2001; 1(1):3-9.
17. Sharma BD, Hore DK, Pandey G, Wadhwa BM. Genetic resources of bamboos in North Eastern Region of India, Indian Journal of Forestry. 1992; 5:44-51.
18. Tejwani KG, Dhruva Narayana VV. Reclamation of small and medium sized gullies in Gujarat Ravines. Journal of Soil & Waer Conservation. 1960; 8(2&3):26-29.
19. Tejwani KG, Gupta SK, Mathur HN. Soil and Water Conservation Research 1956-71. Indian Council of Agricultural Research, New Delhi, 1975.
20. Tong Jianning. Biomass structure changes of *Chimonobambusa guadrangularis* before and after reclaimed. Journal of Fujian Forestry Science and Technology. 2007; 34(1):110-113.
21. Yanhui W, Yongmin L. Hydrological characteristics of a moso-bamboo (*Phyllostachys pubescens*) forest in South China. Hydrological Processes 1995; 9(7):797-808.
22. Zhou Ben-zhi, Fu Mao-yi, Xie Jin-zhong, Yang Xiao-sheng, Li Zheng-cai. Ecological functions of bamboo forest: Research and Application. Journal of Forestry Research. 2005; 16:143-147.