Discussion on the Effect of the New Cutting Mode of Neosinocalamus Affinis Forest in Sichuan Area on Bamboo Forest Construction

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Abstract. *Neosinocalamus affinis (Rendle Mcclure)* is an important bamboo species in SiChuan province, and its industrial development is strongly restricted by the increasing labor cost. This experiment is intended to explore a more convenient and low cost cutting mode without affecting the recovery of bamboo forest. The experimental results showed that the all-fell pattern did not affect the nutrient status of the soil, and the selective cutting mode close with lower stubble and retention of about a half of the bamboo clump didn't affect the recovery of the bamboo forest, which could be used as a new mode for the cutting of bamboo forests.

1. Introduction

Neosinocalamus affinis (Rendle Mcclure) Keng.f) is an arborous sympodial bamboo. It is native to China and distributed mainly in the Sichuan Basin, and is also found in Gansu, Shanxi, Hubei, Hunan, Chongqing, Guizhou, Yunnan, Fujian and Guangdong 1]. It is suitable for growth in areas with elevations below 1000m, annual average temperatures above 14°C, average temperatures above 4°C in January, annual precipitation above 800mm, and relative humidity above 70% [2]. *Neosinocalamus affinis* is one of the largest bamboo species with a wide range of uses in Sichuan and even in the southwestern forest area [3, 4]. It is a kind of small straight and tough bamboo, which has a little difference in diameter. It is easy to be split and restructuring. Restructuring bamboo have the advantages of high utilization rate of materials, wide source of raw materials, and low cost, and can be used as construction template, floor, packing board, cabin floor, etc., and have a good market prospect [5, 6]. However, with the social and economic development, the labor cost of planting and cutting bamboo is increasing, and the price of bamboo products continues to decline under the impact of international trade, which is a great blow to the enthusiasm of farmers for planting.

Clear-cut is a method of forest cutting that cuts all the trees on the cutting area during a harvesting season. Selective cutting refers to the selective cutting of all forests on the cutting forest area. At present, the harvesting method of China's *Neosinocalamus affinis* forest is usually selective cutting. In a nutshell, selective cutting is a method of leaving the first and second year of bamboo pole and cutting the three-year-old bamboo for each cutting season [7]. This method of cutting is extremely costly and does not facilitate the use of mechanical operations, which greatly restricts the development of the paper industry. At present, most of the paper-making companies in the south of Sichuan are in a state of strenuous difficulty. The fundamental reason is the highly bamboo cutting costs. Therefore, it

is of great significance to explore a kind of felling mode that is more efficient and cheap without affecting the construction of *Neosinocalamus affinis* forests. At present, there is no report on the related research on the new cutting model of the *Neosinocalamus affinis* forest. This experiment borrowed the clear-cutting model commonly used in other forest types and applied it to cutting on the bamboo, the purpose is to explore the impact of clear-cut on the regeneration and construction of *Neosinocalamus affinis* forests and bamboo forest production.

2. Materials and Methods

2.1. Test Site Overview

The test site is located in the number of frost-free days in Sichuan Province for more than 300 days, the average annual number of frost days is 4.2 to 9.4, and the average annual number of snowfall days is only 1.0 to 2.7. The climate is humid and rainy. The average annual rainfall is over 1000mm in most regions, and it accounts for about 80% of the annual rainfall in summer and autumn. It only accounts for 20% in winter and spring, and the precipitation varies greatly from year to year. The experimental forest is pure *Neosinocalamus affinis* forests with acid purple soil, bamboo forest base in Mata Country, Leshan City with an altitude of 360 meters above sea level, belongs to the mid-subtropical zone, with four distinctive seasons, and rainy season which coincided with high temperature. The annual average temperature is between 16.5 and 18.0 degrees Celsius, and the average annual slope is 20 to 30 degrees. The bamboo spacing between clumps is 2 to 2.5 meters. The bamboo forest has not been harvested for 3 years. There are a few weeds in the forest.

2.2. Experimental designs

The selection of soil and site conditions in the bamboo forest base were basically the same, three healthy groves of *Neosinocalamus affinis* trees were used as test samples, each sample plot was about 1.5hm^2. Within each sample plot, randomly select clumps of bamboo of similar size, set 6 treatment zones, traditional selective cutting of one clump on T1; clear cutting of one clump close to the earth on T2; clear cutting of one clump with high stubble of 1m on T3; 3/4 clear cutting of one clump close to the earth onT4; 3/4 clear cutting of one clump with high stubble of 1m on T5; 1/2 clear cutting of one clump close to the earth on T6; 1/2 clear cutting of one clump with high stubble of 1m on T7. In February 2014, the bamboo forests were felled according to the above-mentioned 7 different treatments. Each group consisted of 6 cages and repeated 3 times. They were numbered and recorded. In 2015 and 2016, the T1 treatment will continue to be thinned and the remaining treatments will not be felled. From the third consecutive year in 2014, the number of bamboo shoots, number of bamboos and base diameter of each group were calculated after being shot in the middle and late August. In 2016, 3 cages were randomly selected from each group and soil samples were collected at 50 cm below the bamboo forest to measure organic matter content, total nitrogen content, total potassium content, total phosphorus content, nitrate nitrogen content, ammonium nitrogen content, microbial biomass carbon content, and microbial biomass nitrogen content.

2.3. Data Analysis

The data was analyzed using SPSS 13.0 for two-way analysis of variance and EXCEL2007 for charts.

3. Results and Analysis

3.1. Effect of Felling Modes and Years on the Growth of Sacrifice

Table 1 below shows the data of the growth conditions of the *Neosinocalamus affinis* forests under the treatment of 7 kinds of cutting methods. Investigation of the number of bamboo shoots, number of bamboos, and average stem diameter of the 6 caged *Neosinocalamus affinis* in each group can be used to intuitively reflect the recovery of the *Neosinocalamus affinis* forest. The number of bamboo shoots

and the number of dead bamboos can reflect the impact of cutting methods, years, and other factors on the growth of the *Neosinocalamus affinis* forests.

Table 1. Effects of Different Felling Modes and Years on the Growth and Construction of the *Neosinocalamus affinis* forests

Cutting method C	T1			T2			T3			T4			T5			T6			T7		
Years Y	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Total number of shots in the group	168.33	192.67	198.67	156	120.33	144.33	174.67	162.33	176.67	150.33	132.33	160.67	192.33	168	210.67	192.67	150.33	156.67	180.67	168.67	210
Total number of bounced in the group	68.67	66.33	43.33	60	44.33	18	54.33	30.67	24.33	48.33	30.67	42.67	86.67	84.33	42.33	88.67	54	64.33	74.67	52.33	48.33
Total number of bamboos in the group	102.67	120.33	108.33	12	30	56.33	37.67	36.33	42.33	30.67	36.33	62.33	54.33	42.67	90.67	24.33	66.33	68.33	30.67	72.67	96.33
Intragroup assembly bamboo deaths	18	36.67	42.67	12.33	6.67	18.33	41.33	18.67	36.33	24.33	24.33	36.67	42.33	18.33	19.33	24.67	13.33	30.33	48.67	24.33	43.33
The average diameter of bamboo in the group (diameter cm)	7.37	6.43	6.21	3.01	3.84	4.06	3.33	3.43	5.07	3.27	3.91	4.53	3.59	4.42	4.93	3.77	4.65	5.71	3.92	5.31	5.29

* Withdrawal of bamboo shoots indicates that bamboo shoots died after the harvest because of nutrition or insect damage; Bamboo finger reached the acquisition standard *Neosinocalamus affinis*, with an average diameter of >3cm.

3.1.1. Effects of harvesting patterns and years on the number of bamboo shoots from Neosinocalamus affinis The number of bamboo shoots is a direct indicator of the germination ability of the Neosinocalamus affinis mother bamboo shoots, and also a sign of the normal nutritional status and physiological metabolic activity of mother plants. As shown in Figure 1, compared with the traditional cutting mode, different degrees of clear-cutting models have different degrees of influence on Neosinocalamus affinis shoots' ability to shoot out. Through multiple comparisons of LSD, it was found that there was no significant difference in the number of shoots fired in the first year of all treated bamboo shoots, indicating that the number of bamboo shoots produced in this year was mainly affected by the growth status of the bamboo forest in the previous year and the accumulation of nutrients, as well as the current year. The weather conditions are related. At the same time, it can be found that the number of fired bamboo shoots of Neosinocalamus affinis under the various treatments of clear cutting in the second year is significantly lower than that of T1of 32.16, in particular, T2 and T4. The number of bamboo shoots dropped to 20.01 and 22.04, respectively, which was extremely significant compared to T1. This shows that the above-ground biomass of bamboo in the clear-cutting mode is much lower than the traditional model, which greatly affects the underground nutrient accumulation in the bamboo forest, and thus affects the number of bamboo shoots in the second year of the bamboo shoots, especially the clear-cut mode that leaves no piles. The effect of photosynthetic capacity is even greater. However, from the third year's data, most of the clear cutting patterns of the bamboo forest began to recover, and the T5 and T7 treatment and traditional cutting mode are not even significant difference.

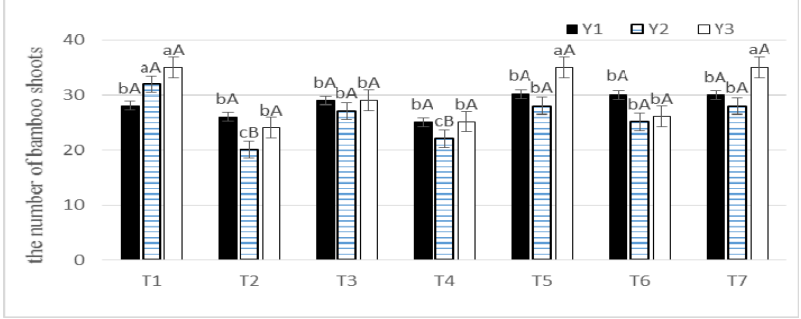

Figure 1. Effect of different harvesting modes and years on the number of bamboo shoots from *Neosinocalamus affinis*

3.1.2. Effect of Felling Mode and Year on the Number of Neosinocalamus affinis timber and Crude of Bamboo Bar Bamboo rate is one of the important indicators of the annual growth and above-ground biomass of Neosinocalamus affinis, and multiple comparisons of the number of bamboos planted in Neosinocalamus affinis have been found: All kinds of clear cutting patterns will significantly affect the amount of bamboo, especially in the first year after felling. The number of bamboos in the first year was as low as 2.07 and 3.02 in the first year of T2 (clearing without leaving bamboos) and T3 (leaving without leaving bamboos). Compared with the traditional model of 17.10, it reached a very significant level. At the same time, intuitionistic investigations revealed that compared with the traditional model, the number of bamboo shoots in the first-year cut-off mode had no significant difference, but it was generally small. After a large number of new bamboo shoots have sprouted, a new bamboo is formed, which naturally leads to a significant reduction in the number of bamboos, which shows that clearcut also has a significant impact on the nutrient accumulation in Neosinocalamus affinis forests that year. At the same time, in the third year of logging, there was no significant difference between the numbers of T5 (15.11) and T7 (16.06) and traditional felling (18.09). Through the analysis of the average diameter of bamboo, it was found that although the bamboo harvested under clear cutting also reached the acquisition standard, it was generally significantly lower than the conventional bamboo harvesting mode under the traditional cutting mode in the same year. In the third year of cutting, only the mean base diameters of T6 (5.71cm) and T7 (5.29cm) treatments were not significantly different from T1 (6.21cm).

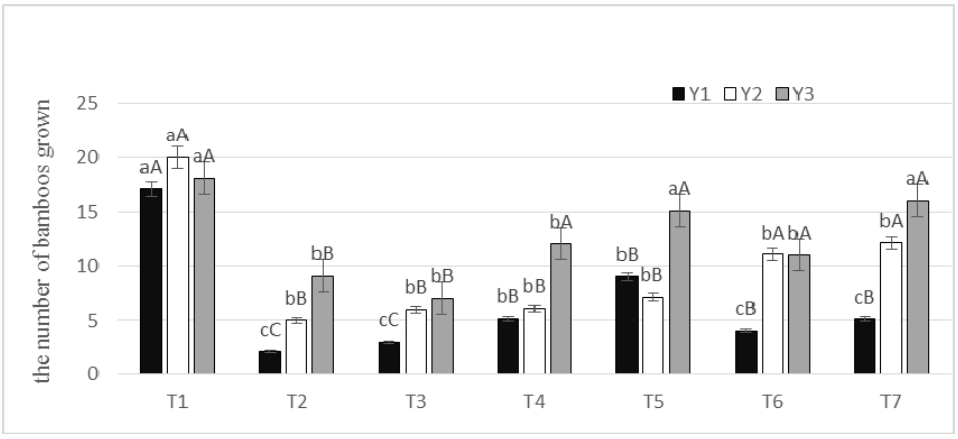

Figure 2. Effect of different logging modes and years on the number of bamboos grown in *Neosinocalamus affinis*

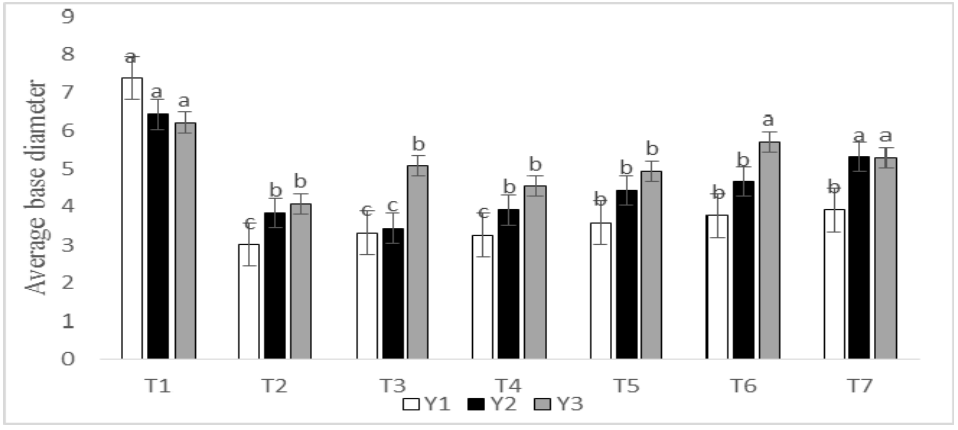

Figure 3. Effect of different logging modes and years on the basal diameter of mature bamboo

3.1.3. Effect of harvest mode and year on the number of bamboo shoots and bamboo deaths

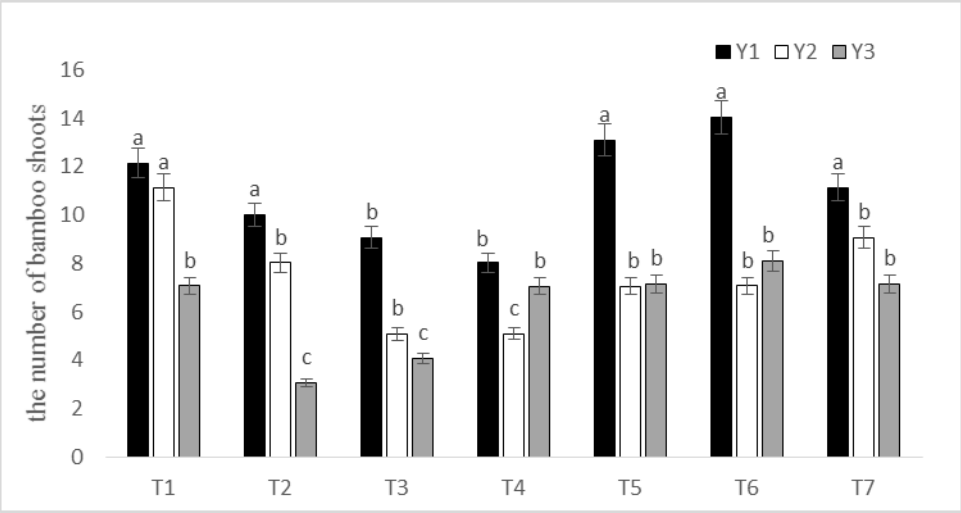

Figure 4. Effect of different harvesting modes and years on the number of bamboo shoots from *Neosinocalamus affinis*

In the process of growth of bamboo shoots after excavation, some bamboo shoots died in the middle and could not be bambooized, the bamboo shoots were sometimes referred to as bamboo shoots. Occasionally, shoot bamboo shoots occurred at about 1.2 m after germination. The withdrawal of bamboo shoots is a reflection of the self-regulating mechanism of bamboo forests, which is mainly due to insufficient supply of nutrients for mother plants, sudden changes in external climatic conditions, and pests and diseases [8]. Through variance analysis and multiple comparison of the test results, it can be found that there is no difference in the number of bamboo shoots in the first year under the clear cutting mode with the traditional model (12.13), but the number of bailouts in the second and third years is generally significantly lower than the traditional model. At the same time, it can be found that the year has a great influence on the number of bamboo shoots withdrawn. From 2014 to 2016, the number of bamboo shoots withdrawn from all treatment groups showed a downward trend.

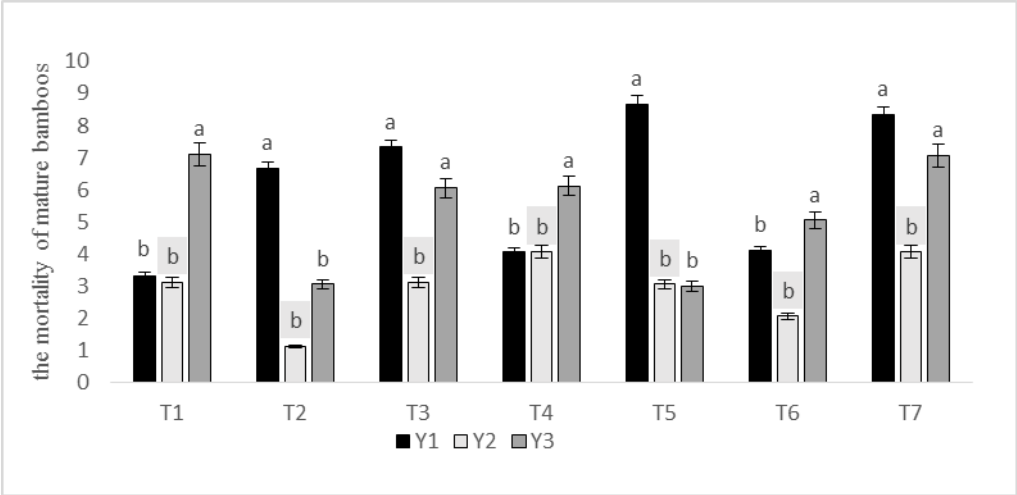

Figure 5. Effect of different logging modes and years on the mortality of mature bamboos

The pests that cause more serious harm in the growth process of the *Neosinocalamus affinis* are Cyrtatrachelus buqueti Guer, Algedonia coclesalis, Notobitus meleagris, and Melanaphis bambusae. Takecallis taiwanus, etc.; the most serious hazards are mainly bamboo coal pollution (Fumago vagans Pers.), Meliola furcata Lev., Trifolium trifolii. (Triposporiopsis spinigera (Hohn) Yamam.)), bamboo rash (Phyllachora orbicula Rehm), bamboo leaf rust (Uredo. ignava Arth.), bamboo-based rot (Arthrinium phaeospermum [9, 10] et al. The investigation found that the bamboo shoots in the test site also had different degrees of pest and disease damage. The pests were mainly large bamboo shoots, black bamboo edge grasshoppers, and Pseudoregma bambusicola. They mainly damaged the tip of shoots and shoots, and were severely damaged. Caused the death of bamboo shoots and bamboo shoots; the main diseases were coal pollution and rust, and in severe cases it caused the death of a cage or whole bamboo. In addition to the death due to pests and diseases, the bamboo stems are relatively thin because of bamboo stems and are more likely to die due to breaking winds. After statistical analysis of the deaths of bamboos, it is found that the year has a great influence on the number of bamboo deaths; in different years and under the cutting mode, there are significant differences between the number of bamboo deaths in the various treatment areas; the first year of logging is T2 (6.67), T3 (7.33), T5 (8.67), and T7 (8.33) bamboo deaths were significantly higher than T1 (3.33). This may be due to the fact that the clear-cut mode has cut off most of the branches and leaves of the above-ground part of the bamboo, resulting in less support around the new bamboo rod and more likely to be caused by falling down due to strong winds.

3.2. Effect of Different Felling Modes on Undergrowth Soil Condition of Neosinocalamus affinis Forest after 3 Years

From Table 2 below, it can be seen that the bamboo cutting methods have different effects on the dynamics of soil organic matter content, and none of them has reached a significant level. Intuitively, the soil organic matter in the cut bamboo forest was significantly lower than that in the thinning bamboo forest after logging for 3 years. It is estimated that the amount of defoliation after clear cutting was significantly lower than that of the invasive bamboo forest, resulting in less soil organic matter accumulation. However, there was no significant difference in soil total nitrogen content and total phosphorus content. The clear-cutting pattern of soil total potassium content was significantly higher than that of the invasive bamboo forest. This shows that the change in the logging mode did not significantly change the soil status of the bamboo forest, which reflected that the clear cutting did not significantly change the ecological environment of the bamboo forest.

Table 2. The soil condition of the bamboo forest in different cutting modes

deal with	Nitrate nitrogeng/cm3	Ammonium nitrogen g/kg	Microbial biomass carbon			Microbial biomass nitrogen			Organic matter g/kg	Total nitrogen g/kg	Total phosphorus g/kg	Total potassium g/kg
			Fumigation to extract organic carbon mg/kg	Extracting organic carbon without fumigation mg/kg	Microbial biomass carbon mg/kg	Fumigation to extract nitrogen mg/kg	Extracting nitrogen without fumigation mg/kg	Microbial biomass nitrogen mg/kg				
T1	4.317	2.860	53.28	30.36	60.32	17.20	9.58	16.95	13.00	0.93	0.79	19.42
T2	5.826	5.606	58.42	25.08	87.72	14.04	10.33	8.25	9.29	0.95	0.81	22.91
T3	6.939	4.610	55.25	26.11	76.70	12.05	10.22	4.08	9.50	0.69	0.78	21.56
T4	4.676	3.183	40.62	19.65	58.88	11.02	8.63	9.77	9.79	0.79	0.73	22.91
T5	5.275	6.803	50.14	28.31	57.46	13.83	9.73	9.11	11.01	0.87	0.70	24.00
T6	8.742	3.094	62.12	33.04	76.51	16.63	7.57	20.15	10.41	0.94	0.78	26.83
T7	6.975	3.863	53.41	23.93	77.58	16.75	10.05	14.90	12.82	1.02	0.66	25.75

4. Conclusion

(1) Different logging modes have a significant effect on the regeneration of *Neosinocalamus affinis* Forest. T5 (remaining 1⁄4 of the remaining pile of bamboo leaves 1/4), T6 (1/2 of the piled bamboo left behind), and T7 (leaving 1/2 of the remaining pile of 1m bamboo leaves) There are no significant

differences in the number of bamboos, the number of bamboos produced, and the bamboo base diameter of the finished material compared with the traditional selective cutting model. Bamboo piles can accelerate the recovery of bamboo forests in the early stage and slightly reduce the degree of lodging of bamboos. However, the retention of piles will increase the difficulty and cost of workers' cutting. However, T3 and T7 treatment of bamboo forests will not be much noticeable in the third year. The difference is that, considering comprehensively, about 1/2 clear cutting model of T6 can be used as a new type of bamboo harvesting model in production.

(2) The content of soil organic matter after clear cutting was slightly lower than that of the traditional model, but there was no significant difference. Each cutting mode had no significant effect on soil nutrient status.

5. Discussion

Clear cut cutting is a logging operation mode in which a whole piece of forest tree is harvested at one time. The operation time is concentrated, the operation mode is simple, and the machine is easy to use. Currently, it is widely used in the felling operations of various economic forests. Now many people have studied it. The influence of clear cut width and time on the regeneration of forests and soil conditions [11-14]. The difference between bamboo and other economic forests is that bamboo is a different-aged forest rather than the same-age forest. Therefore, in addition to the study on free-cutting of bamboo and bamboo in 2017 by Tan Hongchao et al. [17, 18], The application of clear cuts on bamboos has hardly been reported or reported. In Tan Hongchao et al.'s experiment, the clear-cut mode commonly used in other economic forests, such as full-scale, banded, and block, was used for the experiment. The test results showed that in the bamboo felling test, the clearer bamboo cutting area after full-cutting was greater, and the bamboo renewal and growth was worse; the strip-shaped clear cut had the best comprehensive effect with a bandwidth of 6 m; in the block cutting, all were Bamboo trees with a cutting area of 25 m2 have the best growth and regeneration. In the same year, Tan Hongchao et al. found that in the clear-cutting test of the bamboo leaves, the selection of 8-12 m strips in the winter is best, while leaving 5-10 cm. However, in these two kinds of bamboos, all kinds of clear cutting bamboo patterns have been found in the clear cutting experiments. The larger the cutting area, the higher the efficiency and the lower the cost, but the bamboo forest is relatively slow to recover. Compared with large scattered or clustered bamboos such as Phyllostachys pubescens and Dendrocalamus japonicus, *Neosinocalamus affinis* has a smaller base diameter and is more likely to die due to strong wind breaking and lodging. Based on the above considerations, this test has improved the traditional clear-cutting model, designed a 1m-high pile to prevent lodging of bamboos, At the same time, the effect of selective cutting, clearing of the whole cage, clearing of the remaining piles, clear cutting of the non-integral cages, and clear cutting of the non-integrated cages was compared with the effect of renewing the bamboos. The final test found that the clear cutting model can greatly reduce the workload of logging in the bamboo forest. The contiguous bamboo forest was rationally allocated and adopted the practice of cutting 1/3 in turn within three years, and basically had no significant impact on the output of the bamboo forest. It can greatly reduce the labor costs of *Neosinocalamus affinis* Forest production.

The bamboo forest selected in this experiment is located in the vicinity of Matai County in Leshan City. The bamboo forest is located in the sunny slope of the sun, and the lighting conditions are good. However, there is no careful management and no fertilizer for many years. Therefore, the bamboo basal diameter is generally smaller and may have a greater impact on the recovery of the bamboo forest. In the follow-up experiment, the lighting conditions around the Muchuan County and the Leshan Lvxin Park were selected to be different, and the slopes were not the same. Combined with fertilization, cutting and other treatments, the impact of the harvesting methods on the construction of *Neosinocalamus affinis* Forest was further studied.

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