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# Evaluation on Woodland Intensive Use

—A Case of Wenhe Operating Zone in Yakeshi City of China

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**Abstract** Based on apprehending the conception of intensive use of woodland, 12 indices are selected from the aspects of economy, society, ecology and so on according to the principles of scientific systematization, collectible index and system inner linkage. A scientific evaluation index system for woodland intensive use is constructed. Range Standardization Method is adopted in order to eliminate the differences among indices; index weight is calculated by the objective variation coefficient weight method. Physio geographic condition, woodland area and forest resource of Wenhe Operating Zone in Yakeshi City, China are introduced. According to the 2004–2008 relevant statistical data, intensive use level of Wenhe Operating Zone is evaluated. Result shows that the intensive use level of this zone shows a general upward trend with relatively fast increase in a particular year, and slight increase in woodland input every year. From the year 2004 to 2005, intensive level of woodland decreases slightly. From 2005 to 2006, intensive level of woodland rises with slight increase in woodland output. From 2006 to 2007, intensive level of woodland rises rapidly with a substantial upward trend in output. From 2007 to 2008, intensive level of woodland declines sharply. Based on this, related countermeasures are put forward for the intensive use of woodland in Wenhe Operating Zone. Firstly, strengthen the input in production factors of forestry, especially the mechanical input, in order to avoid unnecessary waste. Secondly, scientifically evaluate the development potential, breeding mode and planting program of woodland. Conduct a unified plan for market, and develop wildlife breeding properly. Thirdly, scientifically plan the plantation and guarantee the survival rate; increase the post investment in plantation; scientifically plan the logging quota, and ensure a reasonable output and intensive use of wood.

**Key words** Woodland; Intensive use; Variation coefficient weight method; Wenhe Operating Zone of China

Woodland is an important component of forest and the basic space for the development of forestry. Strictly protecting woodland resources is of great significance to the improvement of ecological environment and the sustainable development of economy and society. Especially during the utilization of the woodland, the mode of intensive use not only can ensure the ecological environment of woodland, but also can create a sustainable economic income. Most parts of Inner Mongolia are arid or semi-arid desertification areas with poor natural condition, difficult afforestation, insufficient forest resources, fragile environment and arduous task of strengthening forest protection and maintaining homeland security<sup>[1]</sup>. Yakeshi City is located in the northern part of Daxingan Mountains, east end of Hulunbeier Grassland. There are Daxingan Mountains Forestry Bureau of Inner Mongolia and its subordinate units of 6 forestry bureaus in Yakeshi City. This city, noted for the "forest capital of China", is an important industrial base. Taking Wenhe Operating Zone in Yakeshi City as an example, we study on its intensive use of woodland in order to provide relevant references for decision making.

## 1 Intensive use of woodland

**1.1 Conception of woodland intensive use** Woodland intensive use refers to reasonably increasing the quantity and

quality input of relevant production factors under a limited area of woodland based on the premise of scientific allocation and structure optimization of regional woodland resource, so as to maximize the overall efficiency of woodland utilization, give full play to the potential of woodland use, economize woodland resources, and take the path of sustainable development and latent power expansion for woodland utilization<sup>[2]</sup>.

### 1.2 Evaluation on intensive use of woodland

**1.2.1 Evaluation index system of land intensive use.** Construction of the evaluation system for woodland intensive use mainly conducts comprehensive analysis on economy, society, ecology and other aspects of woodland intensive use. Combining with the development and requirements of the protection of woodland use, a scientific evaluation system is established in order to conduct comprehensive evaluation on the intensive degree of woodland. This paper takes economic woodland as the research objects, and consults to relevant literatures of intensive land use evaluation index based on the principles of scientific systematization, collectible index and system inner linkage<sup>[3-4]</sup>. This paper also selects a number of factors that can best reflect the intensive degree of woodland, and establishes an evaluation system with one target layer, 3 criterion layers and 12 index layers (Table 1).

**1.2.2 Evaluation method for woodland intensive use.** Range Standardization Method is adopted to eliminate the differences in indices of different units, and to conduct standardized processing of the original data.

There are both subjective and objective methods to confirm the index weight. Considering the fixity of index weight, we use the variation coefficient weight method in Objective Valuation Method to make the data comparable under the same index.

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Generally speaking, variation coefficient of a set of data is the absolute value of its standard deviation divided by the mean value. Bigger variation coefficient indicates the greater variation

of index and the stronger ability to distinguish objects. Thus, we should pay more attention<sup>[5]</sup>.

**Table 1 Evaluation system for woodland intensive use**

Target layer	Criterion layer	Index layer
Woodland intensive use	Woodland input B1	Labor input per unit woodland C1 Mechanical input per unit woodland C2 Woodland pharmacy input C3 Per capita woodland area C4
	Woodland utilization ratio B2	Woodland coverage C5 Proportion of adult woodland C6 Proportion of nursery and young plantation C7
Level A	Woodland output B3	Output of forest products per worker C8 Timber production per unit land area C9 Timber production C10 Forestry output value per unit land area C11 Income per worker C12

Standardized values of indices are used to calculate the variation coefficients of indices  $R_i$ ,  $R_i = S_i/\bar{X}$ , where  $i = 1, 2, 3, \dots, n$ ,  $S_i$  is the standard deviation of index, and  $\bar{X}$  is the mean value of index. Index weight is obtained through normalization processing on  $R_i$ :  $C_i = R_i / \sum_{i=1}^n R_i$ .

Scores and weights of evaluating indices after standardization are used to calculate the comprehensive level of woodland intensive use:

$$A = \sum X_j \times C_j \quad (j = 1, 2, 3, 4, \dots, m),$$

where  $A$  is the comprehensive evaluation value,  $X$  is the standardized value of index, and  $C$  is the corresponding weight. Higher comprehensive evaluation value indicates the greater intensive degree of woodland.

## 2 An overview of the research area

Wenhe Operating Zone in Yakeshi City is composed of Babugen, Monagen, Wenhe, Najikan and Wosimen Forest Farms in Beidahe Forestry Bureau. It is located in the southeast slope of Daxingan Mountains, attach to the Nuomin Town, Orogen Automatic County, Hulunbeir City. Wenhe Operating Zone connects Bilahe Forestry Bureau in the east, Wuerqihan Forestry Bureau in the north, Mianduhe Forestry Bureau in the west and Aligeya Forest Farm in the south with the total area of 265 907 hectares.

**2.1 Physio geographic condition** Wenhe Operating Zone is in the transitional zone from southeast slope of Daxingan Mountains to Songnen Plain with the whole landform tilting from west to east. This zone has cold temperate continental monsoon climate characterized by long and cold winter, warm and short summer, big temperature differences between day and night, short frost-free period, abundant rainfall and great seasonal changes. Bila River, an important branch of Nen River, goes through the Wenhe Operating Zone from southwest to northeast. Vegetation is the transition zone of boreal coniferous forest and summer green broad-leaved forest. There are many plant species with complex community type. Wildlife is rich in resources, with more than 40 types of the first and second class national protected animals.

**2.2 Woodland area** Wenhe Operating Zone covers a woodland area of 210 319 hectares, accounting for 79.4% of the total land area; wasteland area is 10 728 hectares, accounting for 16.5%. Among the woodland area, forest area is 207 104 hectares, accounting for 98.5% of the total woodland area; open forest land is 478 hectares, occupying 0.2%; bush forest is 324 hectares, occupying 0.1%; and bald woodland area is 2 413 hectares, accounting for 1.2%.

**2.3 Wood Resources** Total living tree of economic forest in Wenhe Operating Zone is 15 708 769 cubic metres. Among them, forest volume is 14 638 348 cubic metres, occupying 93.2% of the total stock volume; open forest land is 6 628 cubic metres; volume of scattered trees is 1 063 793 cubic metres; fallen dead wood is 222 300 cubic metres. Both the area and stock volume of natural middle-aged forest are the maximum, which are 123 097 hectares and 9 274 844 cubic metres, respectively.

According to the distribution of dominant species, broad-leaved forest has larger proportion. Ratios of area to stock volume of coniferous forest and broad-leaved forest are both 1:9. Age group is unevenly distributed with relatively more middle-aged and young forests. Besides, there is a minimal quantity of recoverable resources. And area and stock volume are relatively abundant based on intermediate cutting. Wenhe Operating Zone has a timberyard with the maximum throughput of 30 thousand cubic metres using motor to transport.

## 3 Intensive use evaluation on the woodland of Wenhe Operating Zone

**3.1 Index and weight of intensive use** According to the data in 2004–2008 *Prepared Work Table of Wenhe Operating Zone, Productive Operation Cost of Managing Forestry, Table of Wood Product Cost, and Questionnaire on Non-wood Forest Resources in the Third Class Area*, we obtain the data of woodland intensive use in Wenhe Operating Zone (Table 2).

Table 3 reports the weight index calculated by the method mentioned above. Weights of B1, B2 and B3 are 0.275 3, 0.215 3 and 0.509 5, respectively.

**Table 2** Data of woodland intensive use from 2004 to 2008

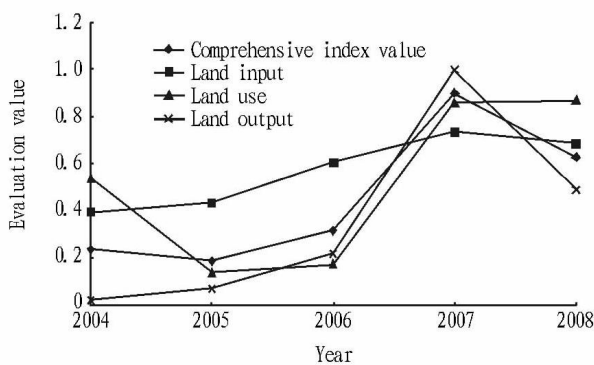
Year	Woodland input				Woodland use			Woodland output					
	C1 people/hm <sup>2</sup>	C2 kW/hm <sup>2</sup>	C3 × 10 <sup>3</sup> yuan/hm <sup>2</sup>	C4 m <sup>2</sup>	C5 %	C6 %	C7 %	C8 yuan	C9 m <sup>3</sup> /hm <sup>2</sup>	C10 m <sup>3</sup>	C11 yuan/hm <sup>2</sup>	C12 yuan	
2004	0.0022	5	0.023	0.38	45.05	76	39.2	13.5	1 200	0.104	22 000	187.13	8 000
2005	0.0022	26	0.025	0.33	44.86	78	37.2	12.5	1 230	0.104	22 000	185.44	8 500
2006	0.0022	26	0.026	0.38	44.86	77	38.4	12.5	1 300	0.104	22 000	187.57	9 200
2007	0.0022	25	0.026	0.38	45.00	79	40.5	13.5	1 420	0.118	25 000	199.65	9 400
2008	0.0022	25	0.026	0.43	45.05	81	39.0	13.5	1 250	0.114	24 000	195.34	8 700

**Table 3** Index weight of evaluation on woodland intensive use

Index	Weight	Index	Weight
C1	0.0857	C7	0.0782
C2	0.0507	C8	0.0921
C3	0.0606	C9	0.1201
C4	0.0782	C10	0.1400
C5	0.0749	C11	0.0942
C6	0.0621	C12	0.0630

**3.2 Evaluation result** Combining with the index weight and standardized value at each layer, we can obtain the values of index and comprehensive index in a given year.

Fig. 1 illustrates that intensive use level of woodland in Wenhe Operating Zone shows a general upward trend with relatively fast increase in a particular year.



**Fig. 1** Woodland intensive use level of Wenhe Operating Zone from 2004 to 2008

Comprehensive index decreases from the year 2004 to 2005, indicating slightly decline of intensive degree. Labor input and mechanical input have enhanced the intensive level of input. Decline in the area of adult and young woodland has reduced the intensive level of land use greatly. And income increase in the third class area has slightly promoted the intensive degree of woodland output. Increase in input and output intensities has been offset due to the sharp decrease in land use intensity.

Comprehensive index is on the rise from the year 2005 to 2006, indicating the increase of intensive degree. Increase in mechanical input and wood locomotive has enhanced the intensive level of input. Rise of adult woodland coverage has slightly promoted the intensive level of woodland use. Forest production value of the third class area has increased sharply, which promotes the slight increase of woodland output.

Comprehensive index rises rapidly from 2006 to 2007, indi-

cating sharp increase in intensive degree. Both adult and young woodland areas increase rapidly due to the good weather, which leads to greater increase in woodland use intensity. Forest products and timber output in the third class area have enhanced greatly, showing a substantial upward trend in output.

Comprehensive index reduces greatly from 2007 to 2008, indicating rapid decrease in intensive degree. Income of the third class area has reduced compared with the last year due to the excessive input of pharmacy, the lack of scientific planning, and the great decrease of support by Forestry Bureau and development zone. Increase in bush forest leads to the slight increase in total coverage, which stimulates the use of intensive strength.

In short, woodland intensive use shows an upward trend in Wenhe Operating Zone in recent years. But input in woodland decreases slightly each year. Due to the policy change in the exploitation of natural forests, there is little increase in wood output in recent years. And unit price of wood changes little. There is only a substantial increase in the intensive use level in 2006–2007 due to the full use of the third class area in the year 2007.

## 4 Countermeasures

### 4.1 Strengthening the input in production factors of forestry

Insufficient input in production factors mainly refers to the lack of mechanical inputs. Wenhe Operating Zone is located in Daxingan Mountains. Wood production is mainly in winter and wood cutting mainly relies on chain saw. Besides, producing area of wood is far away and it is difficult to be loaded or unloaded. Winch of wood locomotive should be conducted in order to arrive at the working place. Therefore, input in machinery should be enhanced. The required machinery includes chain saw, loader, winch machine and automobile. Particularly, we should increase input in the winch machine and the loading and unloading locomotive. In addition, scientific plan is needed during pharmacy input. Establishing a pest and rat monitoring system can help to forecast the prevention work in the next year. Scientific pharmacy input can better suppress disasters, maintain the woodland coverage and the proportion of young and adult forests, and avoid unnecessary waste.

### 4.2 Scientific plan for the use of the third class area

Woodland use of the third class area is an extremely important factor affecting the woodland intensive use level in Wenhe Operating Zone. Although economic forest is the pillar of economy in this zone, economic forest has stable output and price, and its contribution to intensive use is far below that of non-economic timber

revenue in the third class area. Harvesting, processing and selling of wood products still belong to individual behavior, lacking a unified planning and management. This kind of behavior has not yet formed scale economy; its contribution to the income of peasant household is low; and it could easily lead to the destruction of forest ecosystem. Similar problems also exist in breeding industry. Under the advocacy of government in the year 2007, Wenhe Operating Zone increases the input in breeding industry and promotes the production capacity. But the decline in output in the next year reveals the insufficient plan of plantation input, such as excessive livestock and unclear market, which easily leads to economic losses and affects the intensive use. Therefore, under the active guidance of government and development zone, a unified leadership and support for breeding and cultivating personnel should be carried out, in order to fully stimulate the enthusiasm of workers and to obtain a relatively stable and effective output. Thus, suggestions are put forward. Firstly, carry out scientific evaluation on the development potential of woodland. Secondly, optimize the planting and breeding programs in the third class area of woodland; and select the optimum variety and protect the balance of ecological system. Thirdly, carry out a unified planning for the products market of the third class area; provide producers with market information and buyers with products. Fourthly, develop wildlife breeding appropriately; combine the corresponding scientific research units together to obtain better economic and scientific achievements.

**4.3 Strengthening the reserve resources of economic wood** Proportions of young and adult woodlands have relatively great impact on the intensive use. Manpower is difficult to affect the coverage of adult woodland in short term; but manual intervention is effective on the coverage of young woodland. Manual work on nurseries has never been conducted in Wenhe Operating Zone due to the lack of awareness of forest reserve resources. Affected by physio geographic factors, plan for artificial afforestation is insufficient with low survival rate of plantation due to the poor post-management. Therefore, several countermeasures are put forward. Firstly, scientifically plan the plantation, introduce high-quality seedlings, guarantee the sur-

vival rate, and prevent the negative effects of ecological invasion of exotic species on local species. Secondly, increase the post investment in plantation, such as medicament input and regular manpower management. Collect data affecting the growth of young woodland, use the scientific cultivation methods, and improve the survival rate of woodland. Finally, scientifically plan the logging quota, ensure a reasonable output and intensive use of wood. Unified planning of nursery work and adult economic forest logging not only stabilizes the woodland coverage and proportion, but also enables the woodland output and utilization to reach a relatively high level, which is conducive to the construction of ecological environment.

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## 林地集约利用评价研究——以牙克石市温河经营开发区为例

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**摘要** 在厘清林地集约利用概念的基础上, 根据科学系统性、指标可采集性、体系内在联系性 3 个原则, 从经济、社会、生态等方面选择了 12 个指标, 构建了一套科学的林地集约利用评价指标体系。为了消除不同指标间的差异, 采用极差标准化法对原始数据进行处理; 采用客观的变异系数赋值法确定各指标的权重。介绍了样本区域中国牙克石市温河经营开发区的自然条件、林地面积和林木资源。运用 2004~2008 年相关统计数据, 对样区林地的集约利用水平进行了评价。结果表明: 该区林地集约利用水平总体呈上升趋势, 个别年份上升速度较快, 林地投入每年都有小幅增加; 2004~2005 年, 林地集约水平下降, 但下降幅度很小; 2005~2006 年, 林地集约水平上升, 林地产出呈小幅上升; 2006~2007 年, 林地集约水平上升较快, 产出呈大幅增加之势; 2007~2008 年, 林地集约水平下降较快。基于此, 提出了集约利用该区林地的相关对策建议。①加大林业生产要素投入, 尤其是机械投入, 避免不必要的浪费。②科学评价林地的开发潜力、优选养殖和种植方案、进行市场统一规划、适当发展野生动物养殖。③科学规划人工林, 保证成活率; 增加人工林后期投入; 科学规划采伐限额, 保证林地木材的合理产出和集约利用。

**关键词** 林地; 集约利用; 变异系数赋值法; 温河经营开发区