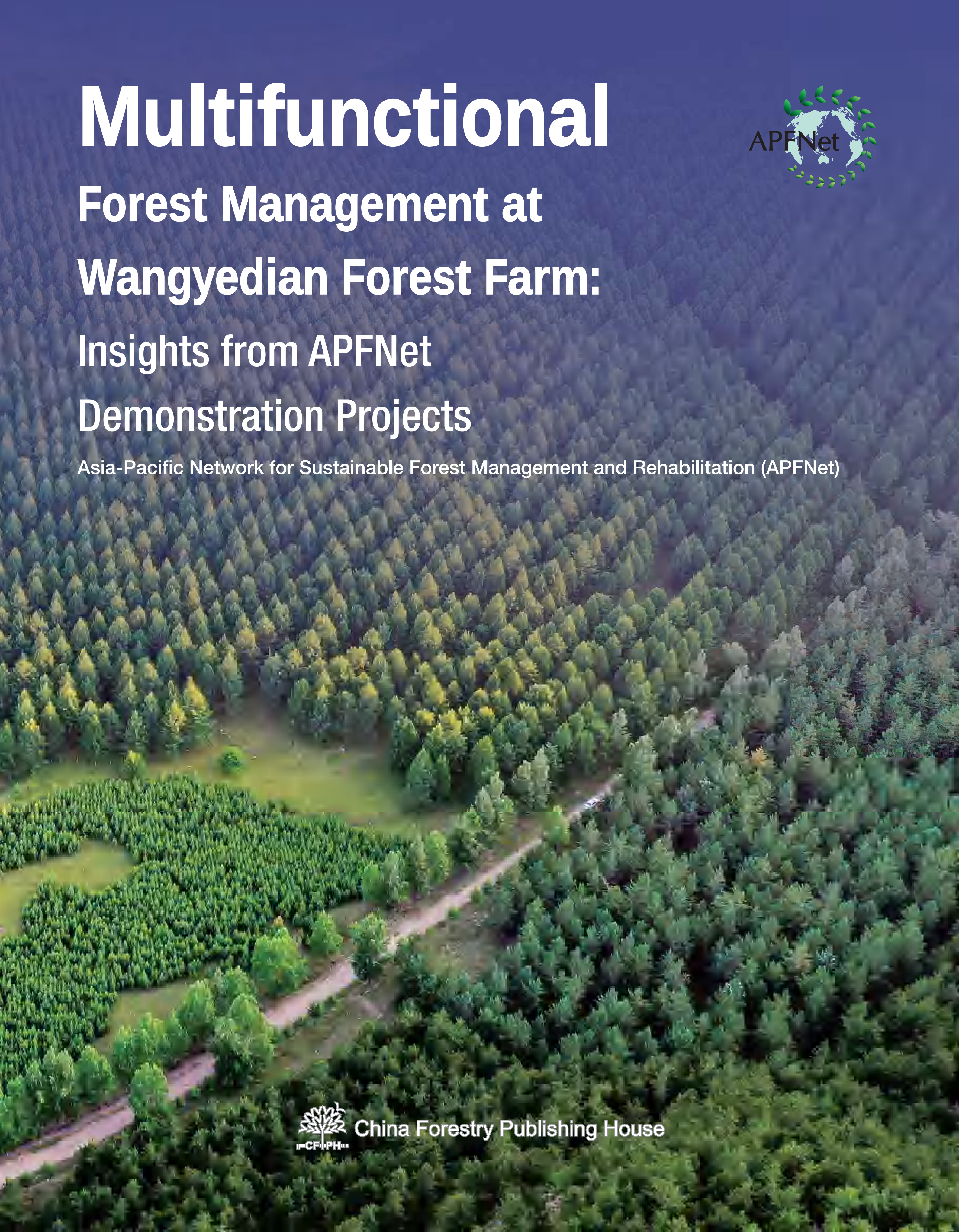
Multifunctional Forest Management at Wangyedian Forest Farm: Insights from APFNet Demonstration Projects

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet)



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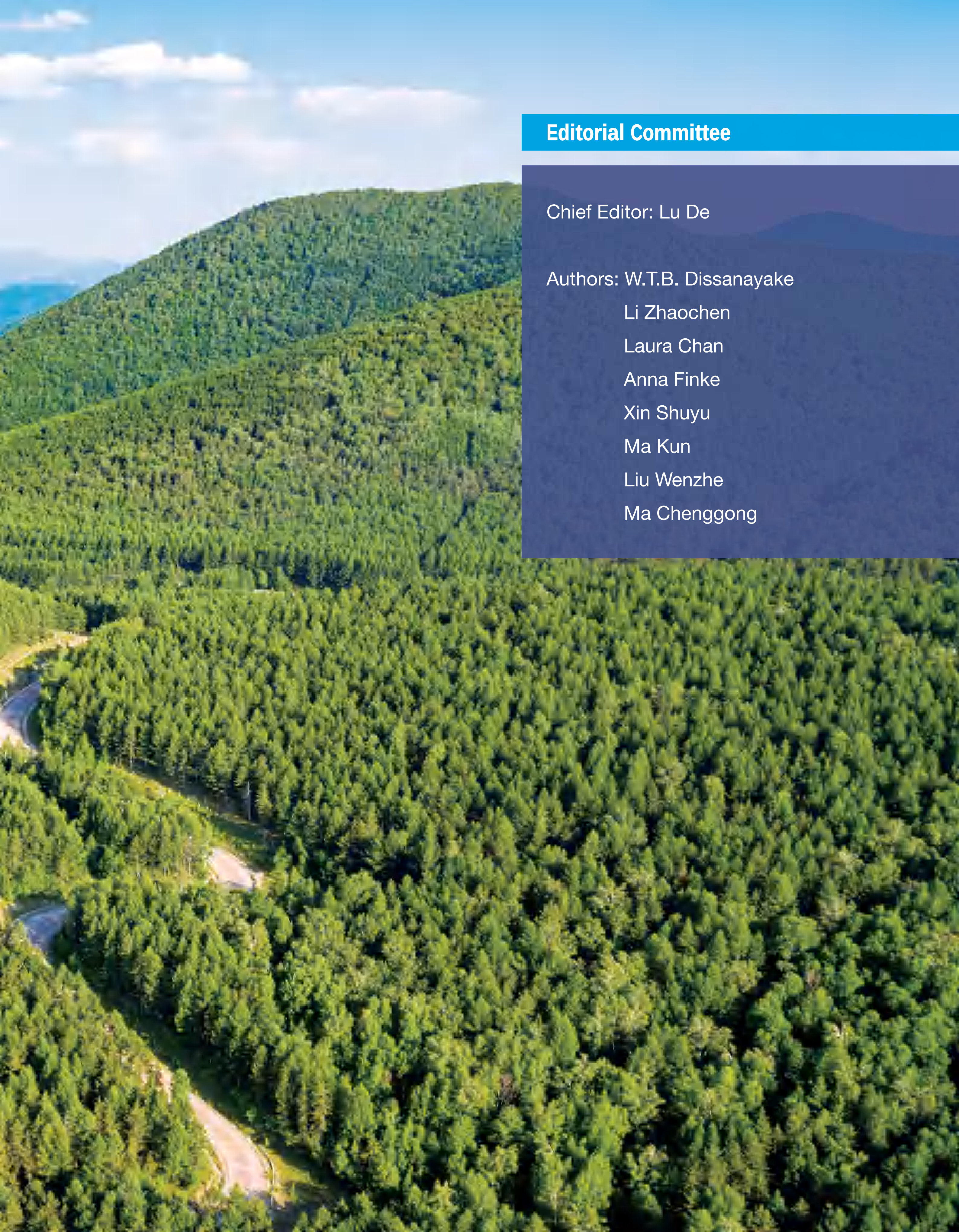

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Wangyedian Forest Farm is a state-owned forest farm located in Harqin Banner, in the southeastern part of the Inner Mongolia Autonomous Region, China. Established in 1956, the Forest Farm was historically degraded due to overexploitation and reliance on monoculture plantations, resulting in reduced forest productivity and biodiversity. Recognizing the need for a more sustainable approach, the management team at Wangyedian Forest Farm committed to adopting an integrated forest management model aimed at restoring ecological functions and economic productivity, enhancing rural livelihoods, and supporting climate change mitigation. To support this transition, bridge critical gaps in technical capacity and funding, and to further promote the approach, APFNet funded a series of projects at the Forest Farm, brought together expert partners, and facilitated knowledge exchange, APFNet funded a series of projects at the Forest Farm, bringing together expert partners and facilitating knowledge exchange.

This report offers a comprehensive overview of the APFNet-funded projects at Wangyedian Forest Farm, focusing on the introduction and implementation of multifunctional forestry and the transformation of Wangyedian Forest Farm into a national reference site and regional forest hub.

Since 2011, APFNet has supported the Multifunctional Forest Management Project at Wangyedian. This project, implemented through three phases, introduced multifunctional forestry through science-based, close-to-nature forest management designed to enhance ecosystem health and achieve economic objectives. Nearly 760 ha of degraded forests have been restored into diverse, mixed-species ecosystems, 66.7 ha of clear-cut land reforested with mixed-species planting, and over 133 ha of demonstration plots have been established to test various forest management approaches. Alongside this, targeted livelihood development initiatives helped boost local income, build local capacity, and diversify livelihoods from the production of various non-timber forest products and eco-tourism.

Capitalizing on the wealth of knowledge and experience gained through the Multifunctional Forest Management Project, and to showcase its activities and demonstration models, the Wangyedian Forest Experience Base Project was launched in 2017. Through targeted infrastructure development, the Multifunctional Forest Experiment and Training Center was transformed from a local demonstration and training facility into a regional forestry platform for nature-based education, technical exchange, and visitor outreach—receiving delegates and visitors from across China and abroad.

As China commits to achieving carbon neutrality by 2030, state-owned forest farms—which manage over 25% of China's forest land—are expected to play a critical role in reaching this goal. The Study on Forest Carbon Storage and Carbon Sink Potential at Wangyedian Forest Farm, launched in 2021, provided an in-depth review of forest resources at the Forest Farm and continued long-term forest management planning. This project was designed not only to enhance the Forest Farm's economic and ecological value but also to increase the Forest Farm's overall carbon stock through science-based forestry planning and sustainable forest management.

The transformation of Wangyedian Forest Farm demonstrates the power of integrating ecological restoration, community development, and science-based forest management. Enabled by APFNet's financial and technical support, the Forest Farm has built a replicable model for multifunctional forest management in northern China and beyond. Today, Wangyedian serves as a knowledge hub and demonstration site, contributing meaningfully to regional sustainable development and global climate goals.

1
Background

1.1 Climate and Environmental Background

1.1.1 Geography

Wangyedian Forest Farm (Figure1) is a state-owned forest farm located in the southwestern part of the Harqin Banner, Chifeng City, in the Inner Mongolia Autonomous Region, China. The Forest Farm covers 25,183.3 ha and spans geographic coordinates between 41.42°–41.65°N and 118.15°–118.50°E, with a central point at 41.5543°N, 118.3825°E (Xu et al., 2018).

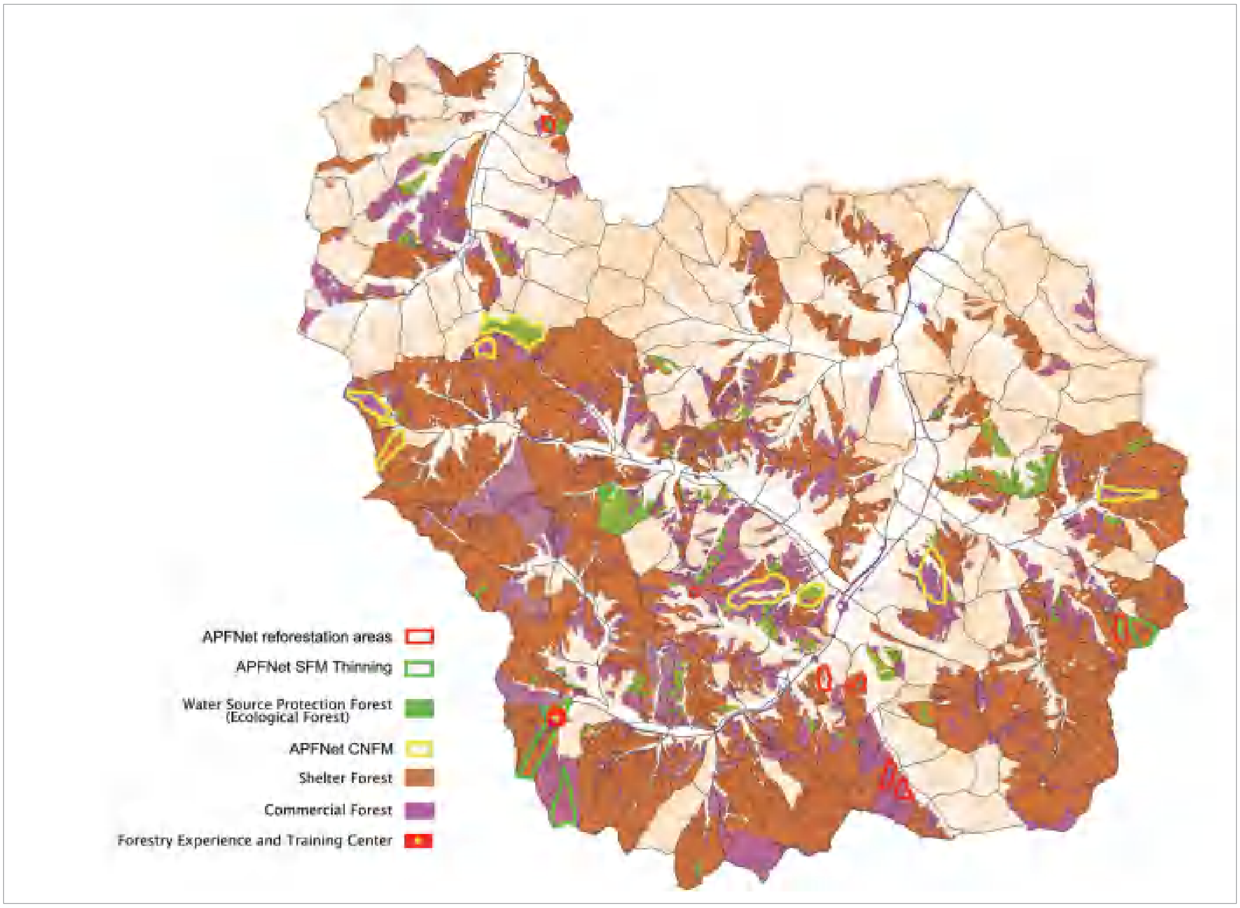


Figure 1: Map of Wangyedian Forest Farm, its different forest types, and APFNet project sites

The Farm is located at the northern end of the Yanshan Mountains and borders the North China Plain, sitting at an important junction in the Qilaotu Mountain belt. The terrain at the Farm exhibits a stepped, descending profile from high southwestern escarpments to lower northeastern depressions. The elevation range, from 800 m to 1,890 m above sea level, supports three distinct landscape features:

- Ridge formations: steep, parallel mountain ridges with slopes of 20°–35°.
- Valleys: north-south trending lowlands with Quaternary sedimentary deposits.
- Denudational platforms: flat surfaces at 1,200–1,500 m above sea level formed by prolonged erosion during the Mesozoic era.

1.1.2 Climate

Wangyedian Forest Farm experiences a continental monsoon climate. Rainfall ranges from 300 mm to 500 mm annually, predominantly falling in July and August. This period accounts for 70%–80% of the total annual precipitation (Li et al., 2020a). Typically, the winter season sees snow accumulations of around 190 mm.

The area maintains an average annual temperature of 4.2°C (Li et al., 2020a). January is the coldest month, averaging -10.4°C, and July is the hottest, averaging 21.7°C. The area enjoys lengthy sunshine, with annual sunshine hours between 2,800 and 2,900 hours, the highest in spring, accounting for 27.4% of the annual total (Jiang et al., 2020).

1.1.3 Hydrology

Wangyedian Forest Farm is located in the upper catchment of the Xiliao River Basin (Table 1). The Farm is located in the source catchment of the Xibo River, which is an important part of the Laoha River system. The basin's river flow patterns are influenced by two main factors: orographic precipitation and groundwater from sandstone aquifers. In spring (March–April), melting snow contributes about 28% of the river's annual flow, while summer monsoon rains (July–August) provide around 55%.

Table 1: Key hydrological parameters of the Xiliao River Basin (Chifeng Water Resources Bureau, 2021)

Metric	Value
Drainage area	1,090.5 km^2
Strahler stream order	4th
Annual discharge	78.16×10^6 m^3
Baseflow index	0.38
Sediment yield	1.2 t/ (ha·a)

1.1.4 Soil

There are four main types of soil at Wangyedian Forest Farm: brown soil, cinnamon soil, meadow soil, and black soil (Yan et al., 2015). Typical brown soil predominates and is primarily distributed on the shaded slopes of mid- to low-elevation mountains between 900 and 1,800 m. This subtype supports natural secondary forests and covers approximately 90% of the forested areas. Meadow soils occur in the lower-lying zones along riverbanks, while mountain black soil is exclusively found atop Bangchui Mountain (Figure 2).

Figure 2: The landscape view of forests at Wangyedian Forest Farm (Photo: China Pictorial)

1.1.5 Forests

Wangyedian Forest Farm lies within a grassland-forest transition zone and forms an integral part of the Maojingba National Forest Park. The Forest Farm acts as an ecological corridor connecting adjacent forest reserves and contributes to the largest contiguous secondary forest ecosystems in Northeast China (Figure 2).

Forest area

The Wangyedian area has undergone significant forest loss and landscape changes over the past few centuries, particularly due to large-scale deforestation during the late Qing Dynasty (1850s–1910s), which continued through to the end of World War II (1945) (He et al., 2008; Zhang, 2021). However, since the establishment of Wangyedian Forest Farm in 1956, combined with support from China's national reforestation initiatives (see Subsection 1.3.1), extensive reforestation and afforestation efforts have been carried out. As a result, the forest coverage in the area has increased significantly, from just 26.3% in 1956 to over 90% by 2022 (see Box 1 for the historical timeline of landscape change in the Wangyedian area).

Today, the total land area managed by Wangyedian Forest Farm is 25,183.3 ha. Of this, the forest land area comprises 24,921 ha and supports three primary vegetation communities: deciduous broadleaf forests, coniferous plantations, and shrubland (see Table 2 for the distribution of forest area by type at Wangyedian Forest Farm).

Historical Timeline of Landscape Change in Wangyedian

BOX 1

Rich forest resources in the early Qing Dynasty

Harqin, where the Forest Farm is located, dates back to the 16th century and was home to various Chinese ethnic minorities, particularly the Mongol ethnic group. People here mainly led a nomadic lifestyle with some farming, which had minimal impact on the environment. In the early Qing Dynasty (1636–1750) (Baidu, 2022), the Wangyedian area became a feudal estate of the Mongolian nobility. However, the land was still primarily used for low-intensity nomadic herding, with little need for farming, so the vegetation remained largely undisturbed. At that time, forests in the Wangyedian area were characterized by high diversity[1], though no specific data or maps exist detailing the landscape from this period.

Large-scale deforestation in the late Qing Dynasty and World War II

In the late Qing Dynasty, restrictions on access and use of the Wangyedian feudal estate were lifted, leading to an influx of locals and immigrants who began exploiting the forests. After the collapse of the Qing Dynasty (1912), agricultural expansion and population growth further accelerated deforestation. This was compounded during World War II, particularly the Second Sino-Japanese War (1937–1945), when resource extraction and deliberate forest fires turned even more forest lands into bare hills and mountains (Yu et al., 2011). After the forests were destroyed, the ecosystem in the entire region suffered. Animals lost their habitats, soil erosion became more and more severe, and increasingly more land became desertified. Subsequently, other natural disasters such as floods became more frequent[1].

Reforestation after the Establishment of China

Since the establishment of Wangyedian Forest Farm over 60 years ago, large-scale reforestation and afforestation activities have been carried out, and many commercial tree species have been introduced and propagated for local use. To date, the total reforestation area is more than 12,333 ha, an area equivalent to 143 Forbidden Cities! Forest coverage increased dramatically, from 26.3% in 1956 to over 90% in 2022[2]. These reforestation and forest restoration achievements are largely the results of six key forestry programs in China.

[1] Provided by Mr. Xianyu Li, the Director of Chifeng Forest and Grassland Academy, through a virtual interview in December 2023.
[2] Based on internal, unpublished monitoring reports from Wangyedian Forest Farm.

Table 2: Distribution of forest area by type in Wangyedian Forest Farm

Type of forest land	Area in hectares (% of total forest area)
Arboreal forests	23,219.8 (93.18%)
Sparse forest	315.8 (1.27%)
Shrubland	720.4 (2.89%)
Non-forested land earmarked for future afforestation	401.6 (1.61%)
Nurseries	13.6 (0.05%)
Logged areas	13.1 (0.05%)
Open spaces within the forest	47.8 (0.19%)
Firebreaks	1.5 (0.01%)
Other land types	187.1 (0.75%)

Forest origin and dominant species

In the Wangyedian Forest Farm, forested areas can be classified by origin into natural secondary forests and plantation forests; primary forests are absent from the Forest Farm (Figure 3). The natural forests, excluding naturally occurring shrubland, cover over 12,942.6 ha, with a stock volume of 1,798,808 m^3. Key species in these secondary forests include white birch (*Betula platyphylla*), Mongolian oak (*Quercus mongolica*), and Dahurian birch (*Betula dahurica*), among others (Figure 4). Plantation forests cover 10,277.3 ha and have a stock volume of 1,508,101 m^3. Predominant species in these plantations are larch varieties (*Larix principis-rupprechtii* and *Larix olgensis,* Figure 5), Scots pine (*Pinus sylvestris*), and Chinese pine (*Pinus tabuliformis*).

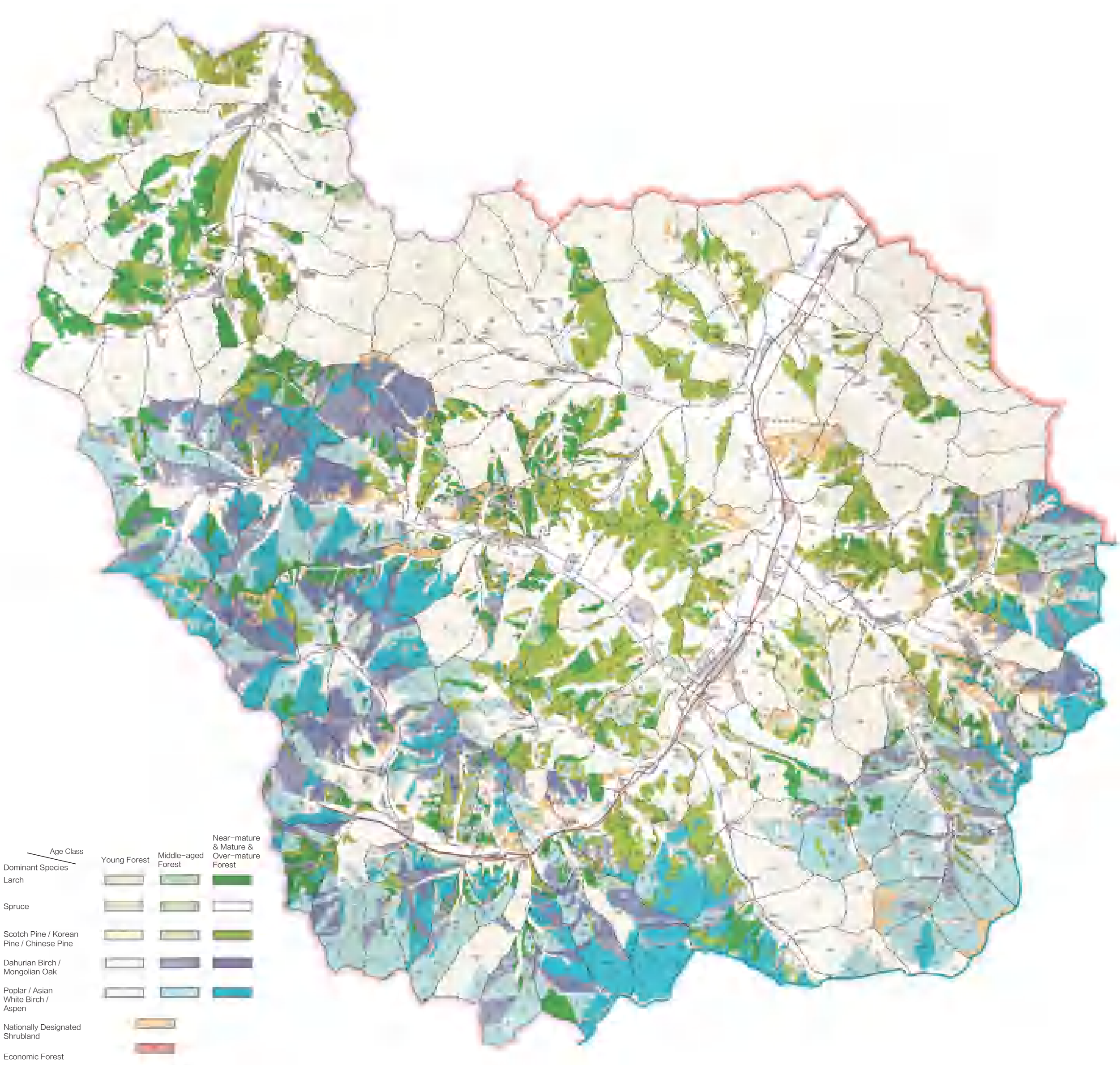


Figure 3: Forest resource distribution map of Wangyedian Forest Farm

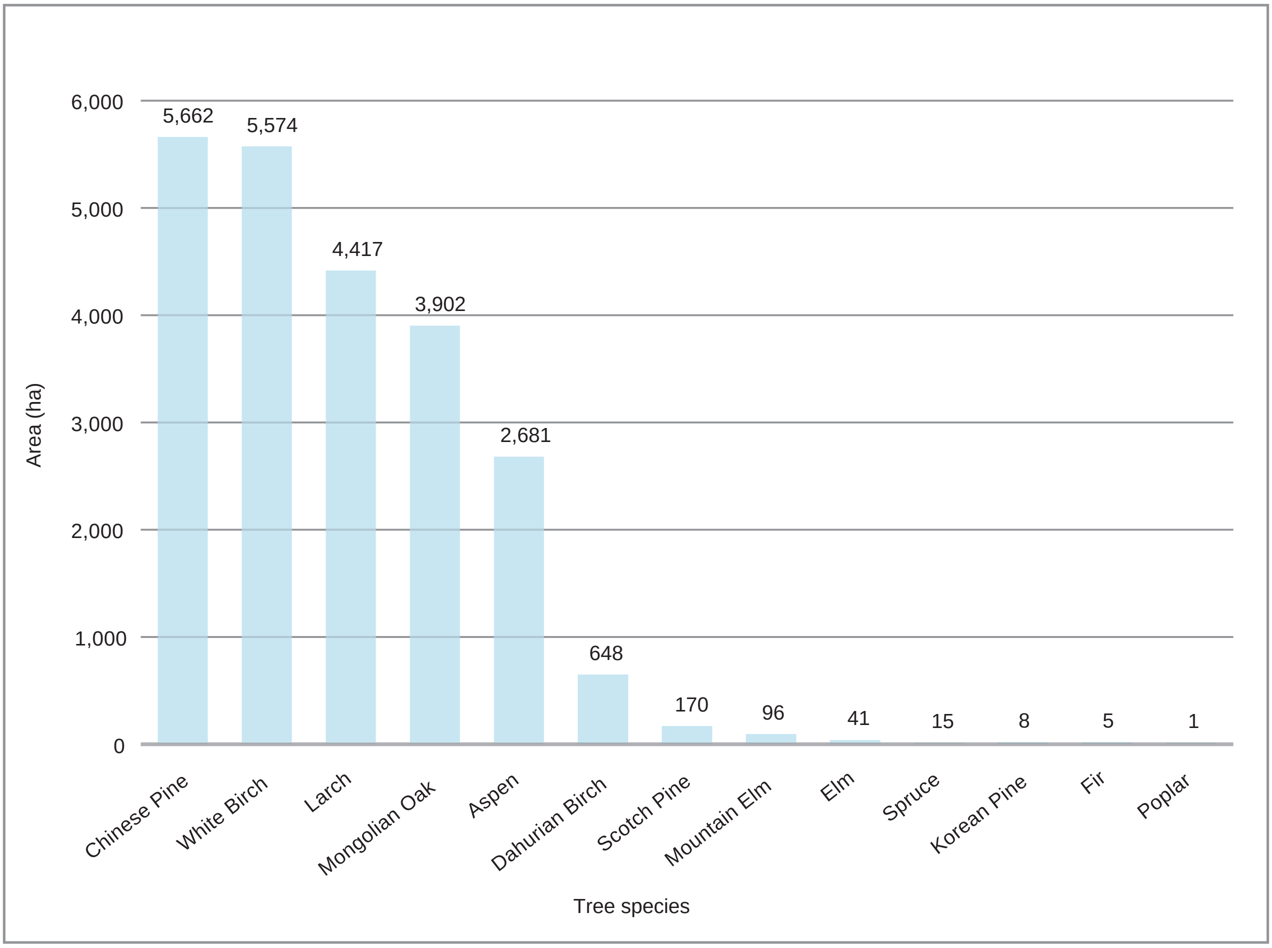


Figure 4: Species composition of forest stands in Wangyedian Forest Farm

Figure 5: The birch secondary forest (left) and larch plantation forest (right) in Wangyedian Forest Farm (Photo: Li Zhaochen)

Forest age and stock volume

As of the latest assessment in 2022, the total arboreal forest area of Wangyedian Forest Farm is 23,219.9 ha, with a total standing stock volume of approximately 3.31 million m^3. The majority of the forest area, over 51.9% (12,058.5 ha), falls within the mature age class, contributing the largest portion of stock volume at 59.27% (1,960,087 m^3). Near-mature forests cover 26.35% of the area (6,118.5 ha) and account for 21.33% of the total volume. Middle-aged forests occupy 11.87% (2,755.8 ha), representing 8.36% of the volume. Over-mature forests make up 6.31% of the area but hold 10.21% of the stock, highlighting their relatively high volume density. Young forests are the smallest category, comprising only 3.54% of the area and contributing just 0.83% of the total stock volume. Table 3 shows the age class distribution and stock volume of arboreal forests in Wangyedian Forest Farm.

Table 3: Age class distribution of forests in Wangyedian Forest Farm

Age class	Area (ha) (% of total area)	Stock volume (m^3) (% of total area)
Young	821.3 (3.54%)	27,446 (0.83%)
Middle-aged	2,755.8 (11.87%)	276,361 (8.36%)
Near mature	6,118.5 (26.35%)	705,369 (21.33%)
Mature	12,058.5 (51.93%)	1,960,087 (59.27%)
Over-mature	1,465.8 (6.31%)	337,646 (10.21%)
Total	23,219.9	3,306,909

Forest categorization under China's Forest Law

Under the provisions of the Forest Law of the People's Republic of China 1998 and its latest amendment in 2019, forests are categorized into two main types based on their intended use: public welfare forests (also known as ecological forests) and commercial forests. The law stipulates that forest land situated in ecologically significant or sensitive areas, primarily aimed at delivering ecological benefits, is classified as a public welfare forest. Conversely, forest land not designated under this category, and is usually used for timber production or other economic purposes, is considered commercial forest (Forest Law of the People's Republic of China, 2019).

As of 2022, the Wangyedian Forest Farm had 18,348.5 ha of public welfare forest and 6,572.3 ha of commercial forest.

1.1.6 Biodiversity

Wangyedian Forest Farm supports a great diversity of flora with 627 documented higher plant species belonging to 88 families and 317 genera. This includes nine species of pteridophyte (from 7 families and 7 genera), 14 species of gymnosperm (from 2 families and 2 genera), and 604 angiosperm species (from 79 families and 308 genera). The diversity can be partly attributed to the farm's location within a transitional floristic zone, which integrates three distinct floristic regions:

1. North China Floristic Region

Dominant species: *Larix principis-rupprechtii, Larix olgensis, Pinus tabuliformis, Pinus koraiensis.*
Associated species: *Picea asperata, Prunus sibirica, Corylus heterophylla, Tilia chinensis.*

2. Northeast China Floristic Region

Characteristic species: *Juglans mandshurica, Tilia amurensis, Prunus cerasifera, Schisandra chinensis, Picea koraiensis.*

3. Mongolian Floristic Region

Characteristic species: *Quercus mongolica, Chrysanthemum zawadskii, Papaver rhoeas, Scutellaria baicalensis.*

Wangyedian Forest Farm also exhibits rich faunal biodiversity, supporting a documented 117 avian species (16 orders, 38 families), 15 reptile and amphibian species (2 orders, 6 families), and 32 mammalian species (6 orders, 14 families). Notably, six raptor species are designated as National Class II Protected Animals: *Milvus migrans* (black kite), *Accipiter nisus* (sparrowhawk), *Accipiter gentilis* (northern goshawk), *Buteo lagopus* (hairy-footed buzzard), *Falco vespertinus* (red-footed falcon), and *Falco columbarius* (merlin).

1.2 Socio-Economic Context

Wangyedian Forest Farm (Figure 6) is located in Meilin Town, whose administrative region covers a total area of 55,100 ha and governs 18 village committees (National Bureau of Statistics of China, 2023). Each village committee includes 6-9 village groups, with a total of 158 village groups across the town. As of the end of 2021, the registered population totaled 35,142, predominantly Han Chinese (80%), with Manchu and Hui communities comprising the remaining 20%.

The region's labour pool consists of approximately 17,000 individuals who primarily engage in migrant work. Workforce capacity is limited, as 72% of labourers lack technical certifications.

Socioeconomic development is further constrained by fragmented and low-yielding agricultural land (83% of farmland is classified as subproductive). Despite these challenges, there are opportunities for progress. These include workforce development programs, agricultural modernization through land consolidation, and industrial development that leverages forest resources to enhance community livelihoods.

In 2021, the area collected CNY 10 million in local tax revenue, completed fixed asset investments totalling CNY 490 million (USD 70 million), and attracted CNY 470 million (USD 67.14 million) in external investments. The per capita disposable income was CNY 9,721 (USD 1,389) (National Bureau of Statistics of China, 2021).

In the same year, Wangyedian Forest Farm's direct income was CNY 2 million (USD 285,714), of which timber sales accounted for CNY 1.72 million (USD 245,714), and other incomes amounted to CNY 280,000 (USD 40,000). The average annual income per employee was CNY 52,000 (USD 7,429).

Figure 6: The landscape view of villages in Wangyedian Forest Farm (Photo: China Pictorial)

1.3 Policy Environment

1.3.1 China's Reforestation Programs

Over the past 30 years, China has made remarkable progress in its forest sector, reversing forest loss through massive investments in afforestation. As a result, total forest cover increased from 157 million ha in 1990 to 220 million ha in 2020 (FAO, 2020), representing the largest national increase in forest cover worldwide during this period. This increase encompasses both naturally regenerated and planted forests. Improved conservation of natural forests was achieved by reducing pressures on their natural ability to regenerate, such as through logging bans, while the increase in planted forests was achieved through large-scale afforestation and reforestation efforts.

The rapid increase in forest cover at Wangyedian Forest Farm, from 26.3% in 1956 to over 90% in 2022, was greatly aided by national policies and reforestation initiatives The National Forest and Grassland Administration (NFGA) initiated several programs between 1970 and 2020 to enhance forest coverage and quality by addressing regional environmental issues, improving ecological conditions, and bolstering rural livelihoods. Key programs include the Natural Forest Protection Program (NFPP), the Conversion of Cropland to Forests Program (CCFP, also known as the "Grain for Green Program"), the Desertification Combating Program around Beijing and Tianjin (DCBT), the Three-North Shelterbelt Program, the Wildlife Conservation and Nature Reserve Program (WCNR), and the Industrial Timber Plantation Program (ITPP) (Ahrends et al., 2017; Wang et al., 2021; Table 4). All of these programs have included parts of Inner Mongolia, among which, four programs, the NFPP, the Three-North Shelter Program, CCFP, and DCBT, have had the greatest influence on the Wangyedian area.

Table 4: China's Six Key Forestry Programs (Li et al., 2018)

Program	Duration	Content
Natural Forest Protection Program (NFPP)	Phase I: 2000–2010 Phase II: 2011–2020 Phase III+: 2021–2050	Aiming to reverse forest degradation through protection: stopping commercial logging in natural forests and reducing timber output in key state-owned forest areas (the Yangtze and Yellow River regions, Northeast China, and Inner Mongolia)
Sloping Lands Conversion Program (SLCP, or "Grain for Green")	1999–present	Converting unproductive sloping cropland (>25°) into forests through Payments for Ecosystem Services (PES), either in cash or alternative benefits e.g. grain subsidy in 25 provinces
Three-North Shelterbelt Program	1978–2050	Aims to curb soil erosion and fight desertification by planting shelterbelts and increasing forest coverage in the northern 13 provinces from 5.05% to 14.95% by 2050
Desertification Combating Program around Beijing and Tianjin (DCBT)	2000–present	Restoring vegetation around Beijing and Tianjin; afforesting sandy areas to combat sandstorms
Wildlife Conservation and Nature Reserve Program (WCNR)	2001–2050	Focusing on the preservation of species and genetic resources, as well as nature conservation, covers typical and representative natural ecosystems and habitats. Developing measures such as nature reserves, wildlife rescue centers, and reproduction and breeding bases
Industrial Timber Plantation Program (ITPP)	Phase I: 2002–2005 Phase II: 2006–2010 Phase III: 2011–2015	Aims to accelerate the cultivation of plantations to increase the effective supply of forest resources and timber to meet the increasing domestic demand for wood. Phase I: Construction of an industrial raw material forest industry belt with a focus on the south; Phase II & III: Extension of the high-yield timber industry belt to the north

As a result of the national forestry policies and programs, accompanied by increased funding from central and provincial governments, China has become a global leader in terrestrial greening, according to NASA (Tabor, 2019). China has successfully halted forest loss altogether and has managed to reverse the trend (Lu et al., 2021).

1.3.2 Forest Management Regulations

In China, three key forest management regulations govern the full rotation of forest management, from initial planting to intermediate thinning to final harvesting. These regulations are as follows:

- *Afforestation Technical Regulation (GB/T 15776-2023) (SAC, 2023).*
- *Regulations for Forest Tending (GB/T 15781-2015) (SAC, 2015).*
- *Code of Forest Harvesting (LY/T 1646-2005) (SFA, 2005).*

Despite forming the national regulatory framework, these regulations in practice present several restrictions and limitations, highlighting the need for further review and improvement (Li et al., 2020). The main limitations observed in Wangyedian Forest Farm are listed as follows:

Afforestation & initial planting density

The *Afforestation Technical Regulation (GB/T 15776-2023)* regulates species selection and initial planting density for afforestation and reforestation activities. However, it lacks guidance for mixed-species planting. In addition, the regulation does not fully account for the relationship between planting density and site index, and how they relate to management objectives. For example, during the 1980s and 1990s, the initial planting densities for *Larix principis-rupprechtii* and *Pinus tabuliformis* plantations were 4,995 and 3,330 stems per hectare, respectively, regardless of the site or management objectives. The 2023 Afforestation Technical Regulation also provides no specific guidance on planting density for *Larix principis-rupprechtii*, and the recommended density for *Pinus tabuliformis* in the Wangyedian area has since been reduced to between 833 and 3,333 stems per hectare.

Thinning

The Regulations for Forest Tending (GB/T 15781-2015) currently only offer guidelines for thinning young and middle-aged stands, and even then, the methods allowed are limited. No thinning guidelines are prescribed for near-mature stands even when these stands have a high stocking density. Because of the high initial planting densities and the low thinning intensity permitted in young and middle-aged forests, thinning operations are usually not able to adjust the tree density enough to optimize the stand for both productivity and profitability. As a result, many stands do not achieve the desirable structure or timber productivity by the time they reach their predetermined ages of biological maturity.

Harvesting

The Code of Forest Harvesting (LY/T 1646-2005) specifies ecologically optimal rotations based on the mean annual increment. However, these prescribed ages should not be interpreted as a fixed rule; rather, they ought to be flexible, and necessary modifications permitted based on site quality, planting density, thinning types, and other factors affecting tree growth and economic profitability.

1.3.3 Development of Multifunctional Forestry

China's forest management objectives have undergone a significant evolution over the past three decades. Rather than being primarily economically driven, current policy priorities focus on mitigating climate change impacts, conserving biodiversity, and safeguarding watershed integrity. This shift aligns with growing public demand for diversified forest ecosystem services, driven by rising living standards and heightened environmental awareness.

The Chinese government's emphasis on the ecological, cultural, and spiritual values of forests alongside traditional economic benefits, recognizes ecosystem vitality as fundamental to sustainable development, and has laid the foundation for the development of multifunctional forestry in China. This paradigm shift has catalyzed the nationwide implementation of ecosystem restoration initiatives and the expansion of protected areas, including national parks, nature reserves, and urban green spaces (FAO, 2021).

The National Forest Management Plan (2016–2050), an administrative planning instrument issued by the NFGA in 2016, proposed that China should adhere to the principle of multifunctional forest management, and determine the primary function of forests according to the ecological location, management objectives, and functional divisions. Accordingly, it proposed the use of three major categories: (1) strictly protected public welfare forests; (2) multifunctional forests; (3) intensively managed commercial forests for industrial uses. The plan also clarified the meaning of multifunctional forest management strategies.

Although the National Forest Management Plan, provides a definition of multifunctional forest management and formally recognizes multifunctional forests as a separate category of forests in China, it lacks operational guidance for implementation. As the Forest Law omits the concept entirely, a policy and regulatory gap remains. Consequently, forest management in practice continues to be confined to the two established forest categories: public welfare and commercial forests.

Due to these limitations, forest management units have limited flexibility to independently carry out the management of multifunctional forests. In public welfare forests, final harvesting or logging is forbidden, though tending and thinning are permitted as management interventions. However, due to the lack of flexibility in the technical guidelines, a one-size-fits-all approach must be used to determine the intensities and frequencies of thinning and tending, leading to ineffective forest management operations.

Similarly, a quota system is implemented for the tending, thinning, and felling of commercial forests. Annual felling quotas, set by the relevant forest authority in accordance with regulations and guidelines, must be used within the year they are issued. This restriction prevents forest management units from applying appropriate prescriptions in silvicultural operations, resulting in a lack of science-based management of commercial forests.

1.3.4 State-Owned Forest Farms

China’s state-owned forest farms were established with government investments shortly after the founding of the People’s Republic of China in 1949. In contrast to collective forests, state-owned forest farms are considered a public good and aim to manage and cultivate forest resources alongside protecting and improving the natural environment. State-owned forest farms play an important role in China’s forestry system. As of 2022, a total of 4,855 forest farms manage 56.67 million ha of state forest land, more than a quarter of the total forest area in China.

In 2015, in response to the lack of long-term plans, inflexible operational mechanisms, and low resilience, the Chinese government rolled out national reforms targeting all state-owned forest farms. The major objectives of these reforms were to change the primary goal of forest farms from timber production to forest conservation and integrated ecological restoration (The State Council of the People’s Republic of China, 2015). This change reflects the broader evolution in thought from a view of forests as timber providers to a deeper understanding of all the ecosystem services forests provide. Other goals of the reform program included improving the governance structure to create streamlined and efficient forest resource management agencies. The reforms required all forest farms to develop science-based forest management plans in order to cultivate and preserve national forest resources in the long term.

1.4 APFNet Projects at Wangyedian Forest Farm

From 2011 to 2025, APFNet provided sustained financial and technical support for a series of projects at Wangyedian Forest Farm. These projects aimed to promote sustainable forest management and environmental conservation while establishing Wangyedian Forest Farm as a regional demonstration site for sustainable forestry. The projects showcase best practice in multifunctional forest management, participatory co-management between local communities and the Forest Farm, livelihood enhancement, environmental restoration, environmental education, and climate change mitigation.

The Multifunctional Forest Management Project, implemented in three phases starting in 2011 and ongoing to 2028, focuses on science-based forestry planning and demonstrates best practices that integrate both ecological, social, and economic objectives. To establish Wangyedian as a regional hub that showcases sustainable forest management and welcomes visitors, the Forest Experience Base Project (2018–2020) was launched, which established nature-based educational infrastructure and a dedicated training center. In response to climate change challenges, the Forest Carbon Estimation Project (2021–2024) developed a mid-term forest management plan that incorporates climate adaptation and mitigation strategies, while also piloting methodologies for quantifying carbon stocks and assessing the forest's carbon sequestration potential.

1.4.1 Developing Multifunctional Forest Management at Wangyedian: A Phased Approach

Phase I (2011–2015): Foundational Development of Multifunctional Forestry

The first phase of the Wangyedian Multifunctional Forest Management Project laid the foundation for multifunctional forest management at Wangyedian Forest Farm. Supported by APFNet, the project focused on demonstrating how ecological, economic, and social benefits can be balanced within a forest management unit.

Key actions included: construction of the APFNet Multifunctional Forest Experiment and Training Center; developing a science-based forest management plan; transforming 466 ha of monoculture plantations and secondary forests into diverse, close-to-nature mixed forests using target tree management, thinning, assisted regeneration, and enrichment planting; and promoting community co-management of forest resources. Community livelihoods were enhanced through mushroom cultivation, seedling production, and eco-tourism. The success of this phase positioned Wangyedian as a benchmark site for sustainable forest practices in northern China.

Phase II (2016–2019): Scaling-Up and Diversification

Building on Phase I, the second phase focused on demonstrating mixed-species reforestation on clear-cut land; expanding the demonstration of close-to-nature forest management from young, middle-aged, and near-mature forests to mature plantations and secondary forests; and promoting ecotourism and nature education in Wangyedian. Over 300 ha of forests were restored using mixed-species planting and close-to-nature forest management and technical guidelines on close-to-nature forest management of larch and Chinese pine plantations were developed. The APFNet Multifunctional Forest Experiment and Training Center was further developed for nature-based education and eco-tourism. The project also developed forest therapy trails and tourism infrastructure, linking ecological restoration with recreational use. Local community capacity was strengthened through training programs, while co-management models were further refined to include eco-tourism activities.

Phase III (2021–2028): Long-Term Monitoring and Infrastructure Enhancement

Phase III focuses on consolidating previous achievements, advancing scientific forest management trials, and improving educational and experiential infrastructure. As of 2025, forest management demonstrations are being conducted on over 133 ha of plantations, testing different thinning intensities and tending techniques. New infrastructure includes a nature education camp with Mongolian yurts (also known as gers), and facilities designed to support nature-based learning. Forest landscape quality and visitor amenities are being improved through greening, wastewater treatment, and recreational upgrades. Capacity-building initiatives are helping Wangyedian staff access advanced training and education. This phase aims to solidify Wangyedian's role as a leading demonstration site for sustainable, multifunctional forest management in China.

Through sustained collaboration with APFNet under the Multifunctional Forest Management Project (Box 2), Wangyedian Forest Farm has emerged as a national reference site and knowledge hub for multifunctional forestry innovation and sustainable forestry practices, showcasing integrated approaches to balancing ecological conservation, timber production, and community engagement.

Wangyedian Multifunctional Forest Management Project

BOX 2

Phase I

Project duration: 2011.09–2015.05
Budget in USD (Total/APFNet): 1,639,686 / 1,213,286

Objectives:

- Construct demonstration sites of multifunctional forests in young to near-mature monoculture plantations and secondary forests.
- Formulate a protection and collection plan for non-timber forest products.
- Construct community co-management demonstration sites on the Forest Farm.
- Promote sustainable forest management and improve management capacity on the Forest Farm.
- Construct the Multifunctional Forest Experiment and Training Center.

Phase II

Project duration: 2016.01–2019.12
Budget in USD (Total/APFNet): 1,641,471 / 1,314,600

Objectives:

- Demonstrate reforestation best practices on clear-cut forests, and close-to-nature forest management on mature plantations and natural secondary forests.
- Develop regional technical guidelines on close-to-nature forest transformation of larch and Chinese pine plantations.
- Expand the APFNet Multifunctional Forest Experiment and Training Center to serve as an outreach and education platform on multifunctional forest management.
- Improve the capacity of local communities and the Forest Farm for practicing sustainable forest management.

Phase III

Project duration: 2021.01–2028.12
Budget in USD (Total/APFNet): 2,450,914 / 2,083,864

Objectives:

- Conduct forest management demonstration tests and continuous monitoring of previously established sites.
- Construct natural education camps and necessary infrastructure for forest experience and natural education.
- Eenhance the landscape quality of the forest experience base through greening and beautifying efforts.
- Strengthen the capacity building of the Forest Farm by sending technical personnel abroad for language training and encouraging managerial staff to engage in professional forestry education.

1.4.2 Wangyedian Forest Experience Base Project

In 2017, during Phase II of the Multifunctional Forest Management Project, APFNet formalized a three-way partnership with Chifeng Forestry Bureau and Harqin Banner People's Government to implement the Wangyedian Forest Experience Base Project (2018–2019; Box 3). Building on the knowledge and lessons gained from the ongoing Multifunctional Forest Management Project, the initiative sought to expand the influence of the APFNet Multifunctional Forest Experiment and Training Center from a local demonstration and training center to a regional forestry platform and tourism center that integrates education, recreation, ecological restoration, and local livelihood development. The project aimed to upgrade the existing center into a comprehensive forestry education hub, known as the APFNet Multifunctional Forest Management Demonstration and Experience Base, with three interconnected objectives: (1) to serve as an experiential learning center offering hands-on forest ecology programs and silvicultural demonstrations; (2) to host international forums and conferences focused on forest management and biodiversity conservation; (3) to develop nature-based tourism infrastructure including accommodation and forest trails.

Wangyedian Forest Experience Base Project

BOX 3

Project duration: 2018.01–2019.12

Budget in USD (Total/APFNet): 3,384,014 / 2,540,829

Objectives:

- Build the APFNet Multifunctional Forest Management Demonstration and Experience Base to integrate sustainable forest management with environmental education and ecotourism to demonstrate and facilitate learning about forest biodiversity, forest therapy, and sustainable usage.
- Establish a long-term, sustainable forest management demonstration site.

1.4.3 The Carbon Estimation Project

Robustly and efficiently quantifying forest carbon stocks and forest carbon carrying capacity at the Forest Farm level is essential for understanding its potential contribution to mitigating climate change. To address this need, APFNet launched a project in September 2021 titled Study on Forest Carbon Storage and Carbon Sink Potential in Wangyedian Forest Farm (Box 4). The objective of this project was to estimate the current forest carbon storage at Wangyedian Forest Farm, forecast its future carbon storage potential, and explore the most effective forest management strategies to enhance carbon storage while balancing other important forest ecosystem services.

This study employed an inventory-based carbon estimation approach to assess all carbon pools within the forests of Wangyedian. The method utilized forest inventory data, including forest type, stand age, stand density, stand volume, mean tree height, and diameter at breast height (DBH). A total of 186 permanent sample plots were selected using a stratified sampling method to calculate biomass at the stand level across various forest types and age groups. The project also supported the development of a forest management plan aimed at optimizing silviculture and forest management practices to promote multifunctional management at the Forest Farm, with a particular emphasis on enhancing carbon storage capacity as a key objective.

Study on Forest Carbon Storage and Carbon Sink Potential in Wangyedian Forest Farm

BOX 4

Project duration: 2021.09–2024.12
Budget in USD (Total/APFNet): 154,412/154,412

Objectives:

- Complete the forest resources investigation of Wangyedian Forest Farm.
- Estimate forest vegetation carbon storage and analyze forest carbon sink potential based on forest resource subclass survey data.
- Develop a multifunctional forest management plan for Wangyedian Forest Farm.

1.4.4 Key Project Partners

The Wangyedian Forest Farm (Figure 7) was established in 1956 as an experimental forest farm, initially under the direct management of the former Ministry of Forestry of China. In 1962, its administration was transferred to a joint authority shared by the former ministry and the Inner Mongolia Autonomous Region Forestry Administration. Subsequently, in 1978, the management of the Forest Farm was transferred to the Harqin Banner People's Government (Li et al., 2018).

Figure 7: The head office of Wangyedian Forest Farm (Photo: Ma Chenggong)

As of 2025, the Forest Farm employs 109 people (Figure 8). Of these, 61 staff members are supported by government funding, and 48 are forest rangers funded by forest ecological benefit compensation funds to manage public welfare forests. Among the total, 25 are professional and technical personnel.

All APFNet-supported projects at Wangyedian were implemented by the Wangyedian Forest Farm of Harqin Banner under the supervision of the Chifeng Forestry and Grassland Bureau. The Chifeng Forestry Science Research Institute was hired as the scientific and technical support unit, with experienced forestry experts regularly visiting the Forest Farm to provide technical guidance. The project also hired a team of experts from the Chinese Academy of Forestry, Inner Mongolia Agriculture University, Renmin University of China, and Beijing Forestry University to provide specific technical guidance.

In addition, the following private sector organizations partnered with the Forest Farm and local community members to support specific project objectives aimed at enhancing local livelihoods:

- Fangxiang Edible Fungi /Fragrant Fungi Technology Development Co., Ltd.
- Dalaisen Seedling Company Ltd.
- Lingguan Tibetan Pig Breeding Cooperative.

Figure 8: Staff working at Wangyedian Forest Farm after enrichment planting in a Chinese pine plantation (Photo: China Pictorial)

2
Multifunctional Forest Management

2.1 Identifying Challenges and Limitations

State-owned forest farms in China have historically been managed with a narrow set of objectives primarily focused on timber production through monoculture plantations (Figure 9). This approach often neglects important forest functions such as biodiversity conservation, watershed protection, and cultural value. As a result, despite the significant expansion of forest cover over recent decades, overall forest quality and growth rates have remained low due to inadequate and inappropriate management practices (Hou et al., 2019; Ke et al., 2020). Many plantations exhibit poor stand structure in terms of spacing, density, species composition, age distribution, and competition control, leading to suboptimal growth, yields, and overall productivity (Bull et al., 2004; Liu et al., 2018; Peng et al., 2018).

Wangyedian Forest Farm is no exception to these challenges and has historically faced issues related to forest quality, structural imbalance, low biodiversity, and socio-economic difficulties in surrounding communities. Over time, it became increasingly clear to both local residents and forest managers that forests offer a wider range of ecosystem services and benefits beyond timber production. As understanding of these diverse values deepened, the management approach at Wangyedian started to shift toward more inclusive and multifunctional objectives. However, the Forest Farm lacked the financial and technical capability needed to transition from traditional forest management toward enhancing the forest's multifunctionality and improving local livelihoods. It was at this point that they sought external technical and financial assistance from APFNet.

Figure 9: The larch monoculture plantation with high density and low biodiversity (Photo: Li Zhaochen)

During the design and implementation of APFNet's demonstration projects at Wangyedian, a comprehensive assessment was conducted to identify critical issues that could hinder the region's long-term sustainable development and adversely affect local livelihoods. These challenges were grouped into five key categories: (1) low forest quality and poor stand structure; (2) policy and regulatory limitations; (3) high risk of forest fires; (4) land-use conflicts with nearby villages; (5) low incomes for local communities. Table 5 provides an analysis of these challenges along with potential solutions and opportunities, many of which were directly supported through the multifunctional forestry practices introduced by APFNet's interventions.

Table 5: The challenges, limitations, and potential opportunities at Wangyedian Forest Farm

	Specific Challenges	APFNet's Solutions / Opportunities	
		Commercial Plantations	**Public Welfare Forests**
Low forest quality and poor stand structure	Unsustainable age groups (Section 2.3)	Long-term forestry planning to refine the forest age structure / Harvesting in mature groups / Intensive management	CNFM / Assisted Natural Regeneration / Enrichment planting and other optimal silviculture practices to improve the forest quality and biodiversity
	Monoculture (Sections 2.4, 2.5 and 2.6)	Mixed species reforestation / Close-to-Nature Forest Management (CNFM) / Enrichment planting and other intensive management and silviculture approaches to increase land productivity and profitability	
	Stock volume / Annual growth rate / Carbon sequestration ability could be improved (Section 2.5)	Intensive management / Optimized silviculture	
	Lack of long-term forest planning (Section 2.3)	Develop a Multifunctional Forest Management Plan and Implementation Plan	
Policy and regulatory limitations (Subsection 1.3.2 and Section 2.5)	Lack of specific regulations on planting density for each species	Develop CNFM standards and technical guidelines suitable for local conditions; Develop a policy brief on improving forest management in state-owned forest farms	
	Restrictions on thinning intensity (near mature forests)		
	Harvest rotation is not economically optimized		
Forest fires	High risk of forest fire (Section 2.7)	Install a forest fire monitoring system and firefighting equipment	
Land-use conflicts with nearby villages	Forests planted by villagers on state-owned lands, blocking access for forest operations	Co-management / Alternative job opportunities / Benefit-sharing mechanisms / Livelihood diversification	
	Forest conservation vs. uncontrolled grazing practices		
Low incomes for local communities	Lack of alternative sources of income/ job opportunities	Develop alternative industries to create job opportunities, such as: Ecotourism (including skiing in winter); Environmental education; Utilizing NTFPs (including Mushroom / Medical Plants / Under canopy vegetable planting through co-management and public-private partnerships); and Carbon credits	

Low forest quality and poor stand structure

One of the primary concerns was the quality and structure of both the commercial plantations and public welfare forests in Wangyedian, which were undermined by unsustainable age groups (Figure 10) and the prevalence of monocultures. This issue can be mitigated through science-based long-term forest planning (refer to Section 2.3) and enrichment planting across both forest categories, intensive management and silviculture within commercial plantations, and Assisted Natural Regeneration (ANR) and Close-to-Nature Forest Management (CFNM) in public welfare forests (refer to Section 2.6). These strategies aim to enhance forest diversity, stock volume, annual growth rates, and carbon sequestration capacity.

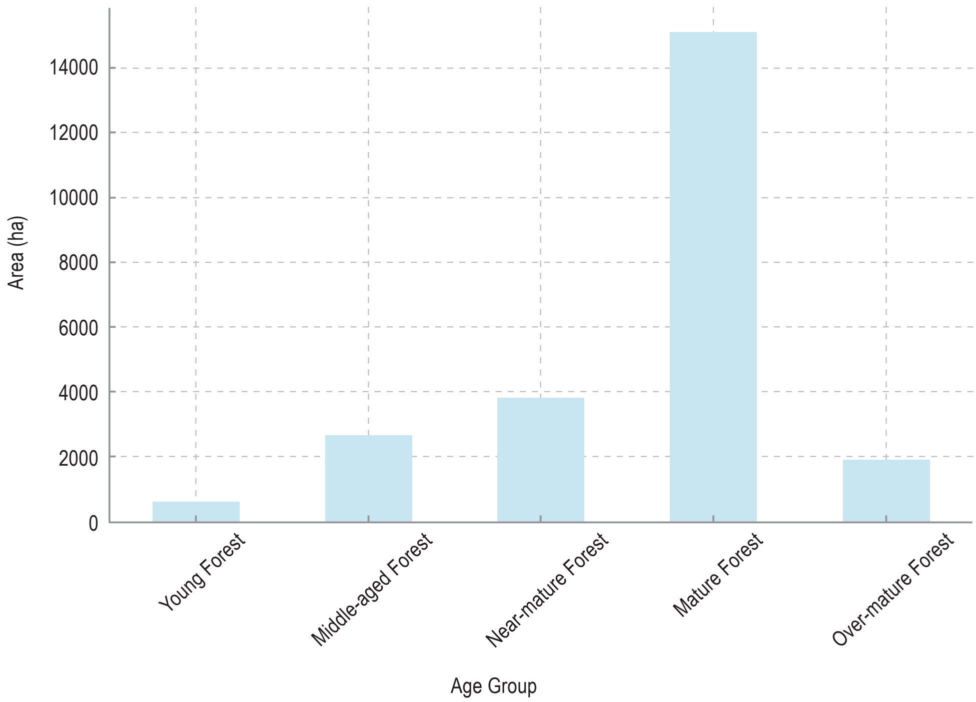


Figure 10: The forest age structure at Wangyedian Forest Farm

Policy and regulatory limitations

Policy limitations present a significant challenge for Wangyedian Forest Farm, particularly due to the lack of clear guidance on initial planting densities and thinning practices for near-mature stands, as well as rigid forest rotation periods that fail to account for site-specific conditions. While China's forest management is governed by three key national regulations—*Afforestation Technical Regulation (GB/T 15776-2023)*, *Regulations for Forest Tending (GB/T 15781-2015),* and *Code of Forest Harvesting (LY/T 1646-2005)*—their implementation at the local level has revealed critical gaps, as illustrated in Subsection 1.3.2.

To complement national regulations and address practical gaps at the local level, the APFNet projects piloted mixed-species planting and intensive thinning across forests of all age classes, culminating in the development of locally applicable CNFM standards and guidelines.

High risk of forest fires

China is increasingly experiencing climate shifts that heighten the risk of forest fires, particularly in areas like Wangyedian. Due to monsoonal patterns, the region's driest months are from November to April, making winter and early spring the peak fire seasons. To address this, APFNet supported the introduction of a real-time forest fire monitoring system and provided essential firefighting equipment—critical steps toward mitigating these growing fire risks (see Section 2.7).

Land-use conflicts with nearby villages

Conflicts with local villagers arise from their use and cultivation of state-owned forest land, as these activities can interfere with forest operations and create tensions between conservation objectives and practices such as uncontrolled grazing. To address these challenges, APFNet supported the Forest Farm in developing co-management approaches (Figure 11), creating alternative job opportunities, and establishing benefit-sharing mechanisms for local communities. Additionally, ecotourism and environmental education initiatives have helped align community livelihoods with conservation objectives, transforming potential conflicts into collaborative efforts for sustainable development.

Figure 11: The typical landscape of the Wangyedian area (Photo: China Pictorial)

Low incomes for local communities

The low income of the communities surrounding the Forest Farm has been a persistent problem. To address this, as mentioned earlier, APFNet helped the farm to explore alternative income sources such as ecotourism, environmental education, and understory planting of mushrooms and medical plants. Additionally, involvement in carbon credit programs—such as the Improved Forest Management (IFM) carbon program in commercial plantations and the Avoid Unplanned Deforestation and Forest Degradation (AUDD) program in public welfare forests—could provide an opportunity to generate additional income while supporting forest conservation.

2.2 Introducing Multifunctional Forest Management to Wangyedian

Multifunctional forestry refers to the management and utilization of forest resources in a manner that recognizes and optimizes their diverse ecological, social, and economic functions. It involves integrating various forest-related activities such as timber production, biodiversity conservation, watershed protection, carbon sequestration, recreational opportunities, and cultural heritage preservation within a single management framework (Figure 12). This approach aims to balance the often-competing demands on forest ecosystems, ensuring sustainable use while safeguarding their long-term health and resilience (Forest Europe, 2011). Accordingly, multifunctional forestry can be regarded as the ability of the forest to provide multiple and interconnected outputs or services, which can be either positive or negative, intended or unintended, complementary or substitutive, and marketable or non-marketable.

Figure 12: Multifunctional forest management framework

The concept of multiple-use forest management planning has evolved rapidly over the last couple of decades, aiming to balance the ecological, economic, and socio-cultural values of forest ecosystems. Forest planning and management must respond to current ecological and social demands, driven by the evolving needs and challenges of today's society. The forest's capacity to provide multifunctional ecosystem services is largely influenced by management practices and the site's prevailing ecological condition, both of which are typically shaped by environmental, biophysical, and climatic factors.

As discussed in Subsection 1.3.3, in China, despite recognition from the NFGA, there are currently no policies or regulations guiding the management of multifunctional forests, resulting in practitioners continuing to effectively treat forests as either commercial or public welfare forests. As a result, China has yet to develop successful models or demonstration projects to showcase multifunctional forest management. To address this gap, APFNet selected Wangyedian Forest Farm as a pilot site to test and refine multifunctional forest management techniques aimed at promoting the sustainable use of forest resources for multiple purposes. This integrated approach—balancing ecological, economic, and social functions—offers a comprehensive response to the interconnected challenges of poor forest quality, policy gaps, wildfire risks, community conflicts, and low rural incomes.

2.3 Forestry Planning

Forestry planning is crucial in modern forestry and is used to define the overarching vision for land use and resource development at a forest-wide scale. Science-based forestry planning serves as the foundational step toward achieving sustainable forest management objectives. By adopting a long-term perspective and applying targeted interventions, such planning enables forest managers to enhance forest quality and build resilient ecosystems capable of meeting the diverse demands of socio-economic development. The FAO defines forestry planning as:

> ***"A continuous process of decisions and actions about alternative ways of using and conserving trees and forests, with the intent of achieving particular goals in the medium and long term."***
>
> **(FAO, 1998)**

Forestry planning horizons vary depending on the objectives of the planning process, the characteristics of the forest ecosystems, and the socio-economic context.

Short-term planning (i.e. operational planning) addresses immediate forest management activities. It involves day-to-day decision-making related to tasks such as harvesting, planting, thinning, and pest management. It aims to optimize forest operations, achieve specific management targets, and respond to immediate challenges or opportunities. The timeframe of short-term planning typically ranges from 1 year to 5 years.

Medium-term planning involves developing strategies and action plans to achieve broader management goals and objectives. It considers longer timeframes, usually spanning 5–20 years, and encompasses multiple operational cycles.

Long-term planning (i.e. strategic planning) involves envisioning the future trajectory of forest ecosystems and formulating overarching strategies to guide management decisions over extended periods. It considers complex interactions between ecological, social, and economic factors. The timeframe of long-term planning usually extends beyond 20 years, often spanning several decades or even centuries. It aims to ensure the resilience, sustainability, and adaptability of forest ecosystems in the face of long-term environmental changes, societal shifts, and economic dynamics.

These planning horizons are interconnected, with medium-term strategies influencing short-term decisions, and both contributing to long-term sustainability goals. Effective forestry planning requires a multi-horizon approach that balances immediate needs with a long-term vision, while remaining adaptable to changing conditions.

In 2015, the Chinese government launched nationwide reforms targeting all state-owned forest farms to address systemic challenges such as the absence of long-term planning, rigid operational structures, and limited ecological resilience. The reforms aimed to shift the primary function of forest farms from timber production to forest conservation and integrated ecological restoration. They also sought to enhance governance by establishing more streamlined and effective forest resource management institutions. A key requirement of the reform was that all forest farms develop science-based forest management plans to ensure forward-looking cultivation, conservation, and sustainable use of national forest resources.

Through the Wangyedian Multifunctional Forest Management Project and the Study on Forest Carbon Storage and Carbon Sink Potential of Wangyedian Forest Farm, APFNet supported the development of two successive forest management plans for Wangyedian Forest Farm—Phase I (2013–2022) and Phase II (2022–2036). Anchored in the principles of multifunctional forestry, these plans provide short- to medium-term strategic guidance to enhance the farm's ecological integrity, social value, and economic returns. Detailed annual action plans for forest operations—such as reforestation, enrichment planting, and thinning—were developed in accordance with government regulations. The experience and practices developed through these initiatives position Wangyedian as a replicable model for sustainable forest management across China's state-owned forest farms.

2.3.1 Data Collection

Accurate and up-to-date data is an essential prerequisite for effective forest management planning. To ensure a solid foundation for decision-making, comprehensive forest resource assessments were conducted at Wangyedian Forest Farm in both 2012 and 2021, before the development of each forest management plan (Figure 13). These assessments included the establishment of both permanent and temporary sample plots to capture a wide range of biophysical data on forest conditions.

Figure 13: APFNet staff participate in a forest resource assessment (Photo: Wangyedian Forest Farm)

Permanent Sample Plots

A stratified sampling approach was used to establish 186 permanent plots across Wangyedian Forest Farm, including 177 plots for trees and nine plots for shrubs (see Figure 14 and 15). The forest was stratified by forest or shrub type and age class (young, middle-aged, near-mature, mature, and over-mature). Nine major forest types were identified, including larch, European pine, Chinese pine, Mongolian oak, birch, Korean aspen, mixed conifer, mixed broad-leaved, and mixed conifer-broad-leaved forests. Additionally, three shrub types, wild apricot, hazel, and spiraea, were identified (some plots included pure shrubland). Using optimal allocation methods, the sample size for each stratum was determined to minimize variance across the dataset.

Each permanent plot was 600 m^2 (24.49 m × 24.49 m). Within each plot, detailed data were recorded, including GPS coordinates, elevation, slope, aspect, forest type, and canopy cover. Individual tree measurements such as species, number, DBH, relative position, mean height, and dominant height were also collected. Additional subplots were used to assess shrub biomass (5 m × 5 m), herbaceous vegetation (1 m × 1 m), and forest litter (1 m × 1 m). Soil samples were taken from three depth intervals (0–10 cm, 10–30 cm, and 30–50 cm) for analysis.

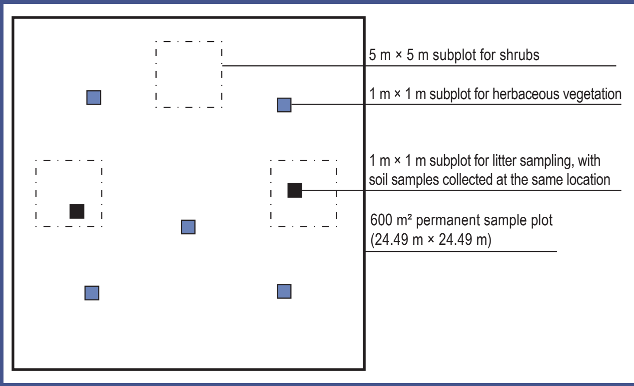


Figure 14: Location and layout of sample plots

Figure 15: Setting up inventory sample plots (Photo: Wangyedian Forest Farm)

Temporary Sample Plots

To complement the permanent plots, 7,800 temporary sample plots were established across the 199 forest compartments (divided into 3,144 sub-compartments[3]) of Wangyedian Forest Farm. Plot coverage was set at a minimum of 1% for plantation forests and 3% for natural forests, reflecting the greater variability found in natural stands. These plots aimed to provide a comprehensive picture of forest composition and age structure at the landscape scale. Data collected included basic site information (GPS location, elevation, slope, aspect, forest type, and canopy cover) and individual tree data (species, count, DBH, mean and dominant height).

[3] A compartment is a large, permanent forest management unit, typically defined by natural or artificial boundaries such as ridges, rivers, or roads. It is the basic planning and mapping unit for forest operations at the management level. A sub-compartment, usually a forest stand, is a smaller unit within a compartment that represents an area of forest with relatively uniform characteristics, such as tree species composition, age class, site conditions, and management history. Sub-compartments are the smallest operational unit used for detailed inventory, silvicultural treatment, and monitoring.

2.3.2 The Multifunctional Forest Management Plan

Utilizing the data and information gathered from the forest resources assessment, the first Wangyedian Multifunctional Forest Management Plan was formulated in 2013, covering the period from 2013 to 2022 and aligning with the principles of multifunctional forest management. Building on this foundation, the second management plan was subsequently developed, outlining a 15-year management period from 2022 to 2036 (Table 6). This second plan is structured into two stages: the early phase (2023–2026) and the later phase (2027–2036).

The primary goal of the plans is to improve forest quality and ecosystem stability through targeted silvicultural measures. These efforts aim to optimize forest structure, strengthen forest protection, enhance land productivity, and make efficient use of non-timber forest resources. In parallel, the plans focus on upgrading infrastructure, conserving biodiversity, and promoting ecological balance to support the long-term sustainable development of the Forest Farm. By 2025, the total arboreal forested area is projected to reach 23,950.98 ha, and by 2035, it is expected to increase to 23,975.98 ha.

Table 6: The target objectives of the multifunctional forest management plan at Wangyedian Forest Farm (2022–2036)

Indicator	Unit	Baseline (2022)	2025 Target	2035 Target
Forest coverage rate	%	95.06	95.11	95.21
Forest growing stock	10,000 m^3	330.69	339.86	374.41
Stock volume per hectare (arbor)	m^3/ha	140.7	146.3	161
Area of preserved natural forest	ha	13,663.0	13,663.0	13,663.0

Management of Ecological Service-Dominated Multifunctional Forests (Public Welfare Forests)

Management Objectives:

The management and operations of these forests focus on ecological restoration, aiming to enhance ecosystem services and ensure effective protection, while strictly preventing the loss of forest land. Silvicultural interventions are permitted to strengthen ecological functions and increase productivity, while also supporting the development of cultural services where appropriate.

Management Measures:

a. Enhancing Ecological Services and Functions

Management prioritizes ecological services and functions by applying thinning, selective cutting, and enrichment planting to improve forest structure, promote regeneration, and enhance resilience to pests and natural disturbances. Sanitation cutting is used for damaged trees, while seed orchards receive targeted care to maintain forest health and genetic resources.

b. Developing Cultural Services

To promote the cultural and recreational value of forests, forest recreation is encouraged where it does not compromise ecological integrity. Recreational infrastructure development must retain existing trees and understory vegetation as far as possible, and may include selective transplanting and planting of visually appealing native species to enhance landscape quality. All activities must follow strict environmental standards to safeguard forest ecosystems.

c. Supporting Provisioning Services

While ecological functions are prioritized, forests also provide tangible products such as timber, seeds, and understory resources. To improve timber production and contribute to long-term timber reserves, management includes moderate thinning to release growth space for selected trees, thereby improving diameter growth and stand quality. Moreover, sustainable use of forest land is promoted by encouraging under-canopy cultivation and breeding of herbs, fungi, or other economic plants, so long as these activities do not harm forest vegetation. These measures help balance ecological protection with economic viability, making efficient use of available resources.

Management of Commercial Plantation Forests with Timber Production as the Dominant Function

Management Objectives:

In commercial plantation forests, where timber production is the primary goal, management focuses on improving profitability and land productivity alongside enhancing overall forest quality. Efforts target the cultivation of high-quality, high-value timber while safeguarding essential ecological functions.

Management Measures:

To accelerate the cultivation of commercial plantation forests, management focuses on forest stands with clear target species and high cultivation potential. Key silvicultural techniques such as CNFM, enrichment planting, thinning, and other intensive management approaches are applied to improve stand productivity and quality.

a. Forest Thinning/ Tending

Tending involves replanting, thinning, and undergrowth removal to improve forest structure, targeting dense young and middle-aged stands. It enhances species composition, tree growth, and wood quality by removing weak, pest-infested, or competing vegetation.

b. Forest Harvesting

To support sustainable management and forest renewal, mature plantations will be selectively harvested and reforested using site-appropriate methods based on the national harvesting guidelines, ensuring both timber production and ecosystem succession.

The preparation of these forest management plans followed a participatory approach. In addition to core forest management activities, the planning process emphasized improving community livelihoods, such as promoting the sustainable use of non-timber forest products (NTFPs) and establishing co-management mechanisms between the Forest Farm and local communities (see Chapter 4). It also prioritized the development of forest tourism and recreation (see Chapter 5), the strengthening of forest management capacity, and the establishment of systems to monitor the impacts of improved forest management practices.

2.4 Mixed-Species Reforestation

Reforestation has been a key focus at Wangyedian Forest Farm since its establishment. However, it was traditionally implemented through conventional approaches, resulting in large areas being planted with monocultures—primarily larch and Chinese pine—at high initial density. These monoculture plantations were managed following the national forest management regulations, which often favored a clear-cutting and replanting system. As a result, the Forest Farm experienced low land productivity and limited ecological benefits.

In contrast, mixed-species reforestation offers substantial ecological advantages by planting diverse tree species within a single area. This method boosts biodiversity, enhances ecosystem resilience, and promotes multifunctionality and long-term sustainability, making it a critical strategy for forest restoration and conservation efforts worldwide.

Prior to the APFNet-funded project, the Forest Farm had limited experience in establishing or managing mixed-species forests, particularly mixed conifer-broadleaf stands. The APFNet project introduced the Farm to mixed-species reforestation with several core principles: (1) incorporating native tree species alongside high-value species such as Mongolian oak, Siberian walnut, maple, and linden; (2) combining coniferous and broad-leaved tree species to enhance biodiversity and accelerate litter decomposition; (3) selecting species based on site-specific conditions—for example, tailoring tree species configurations for varying micro-site conditions, such as the upper and lower parts of slopes (Figure 16).

Figure 16: Mixed-species reforestation progress: (1) After site preparation (top); (2) Immediately following planting (middle); (3) One year post-planting (bottom) (Photo: Wangyedian Forest Farm)

Based on these principles, three distinct mixed-species reforestation models, each tailored to various objectives, were designed and applied to clear-cut areas between 2016 and 2017:

1. Timber-focused mixed plantations: Designed to produce high-quality timber, this model was implemented on 400 mu (26.7 ha) across three clear-cut plots, with a mix of coniferous and local broad-leaved species (Table 7). A total of 94,400 seedlings were planted, including Scots Pine (*Pinus sylvestris*), Chinese pine (*Pinus tabuliformis*), Mongolian spruce (*Picea mongolica*), and Mongolian oak (*Quercus mongolica*).

Table 7: Timber-focused mixed forest plantation design and implementation details

Area (mu)	Tree Species	Mixing Ratio (%)	Mixing Method	Spacing (m × m)	Seedling Type	Silvicultural Measures	Seedling Density (trees/mu)
200	Scots Pine	50	Inter-row Mixed Planting	2 × 2	5-year-old	Weeding and soil loosening, 5 times in 3 years	167
	Mongolian spruce	30			4-year-old		
	Mongolian Oak	20			2-year-old		
200	Chinese pine	50	Inter-row Mixed Planting	2 × 2	5-year-old	Weeding and soil loosening, 5 times in 3 years	167
	Mongolian spruce	30			4-year-old		
	Mongolian Oak	20			2-year-old		

2. Integrated nut and timber plantations: Targeting both short- and long-term returns, this model was applied to 200 mu (13.33 ha) using 51,660 seedlings (Table 8). Korean pine (*Pinus koraiensis*) was planted to provide both edible nuts and timber, while Mongolian spruce (*Picea mongolica*) was included for long-term timber returns. Acer (*Acer mono*) seedlings were densely planted in small planting areas to ensure high survival, with excess saplings later transplanted to other sites for additional benefits.

Table 8: Integrated nut and timber plantation design and implementation details

Area (mu)	Tree Species	Mixing Ratio (%)	Mixing Method	Spacing (m×m)	Seedling Type	Silviculture Measures	Seedling Density (trees/mu)
200	Korean Pine	50	Inter-row Mixed Planting	2×1.5	5-year-old	Weeding and soil loosening, 5 times in 3 years	222
	Spruce	30			2-year-old		
	Acer	20			4-year-old		

3. Recreational and ornamental plantations: Aimed at boosting aesthetic and recreational value, this model was used along roadsides on 400 mu (26.7 ha) with 88,000 seedlings (Table 9). Key species included Scots pine (*Pinus sylvestris*), Chinese pine (*Pinus tabuliformis*), Mongolian spruce (*Picea mongolica*), and Siberian elm (*Ulmus pumila*). Additionally, colorful shrubs and herbaceous plants such as Chinese lilac (*Syringa reticulata*), Williams elder (*Sambucus williamsii*), Chinese pear (*Pyrus ussuriensis*), painted-leaf begonia (*Begonia rex*), and bush clover (*Lespedeza bicolor*) were incorporated to enhance visual appeal.

Table 9: Integrated recreational and ornamental plantation design and implementation details

Area (mu)	Tree Species	Mixing Ratio (%)	Mixing Method	Spacing (m×m)	Seedling Type	Tending Measures	Total Seedlings (trees/mu)
400	Scots pine	40	Strip Mixed	2×1.5	5-year-old	Weeding and soil loosening, 5 times over 3 years	222
	Chinese pine	30	Strip Mixed		5-year-old		
	Colorful trees and shrubs	30	Strip Mixed		2-year-old		

To support high survival rates and healthy early-stage growth, techniques such as planting tall container-grown seedlings (average height of 1.10 m) and using deep planting pits were employed in some of these reforestation operations.

2.5 Researching the Effect of Thinning and Optimal Rotation

Thinning is a commonly used silvicultural practice throughout the world to manage plantation forests. Experimental and simulation-based studies have demonstrated that various thinning measures to remove small or defective trees can increase the growth rate and productivity of retained trees (Nakvasina et al., 2019). Consequently, the profitability of plantations can also be improved. In forest economics, plantation management is optimized by finding the desirable combination of planting density, thinning types and times, species and product mix, and rotation length (Bettinger et al., 2017; Peng et al., 2018). However, as noted in Section 2.1, in Wangyedian, the combination of high planting density and limited intensity and frequency of thinning, mandated by the current forest management regulations in China, has resulted in large areas of overly dense forest stands with low growth rates. Effective thinning is therefore a crucial approach to enhance growth, improve forest quality and productivity, and optimize stand structure.

With the support of the APFNet project, a study was conducted to evaluate the effects of thinning on the productivity and profitability of *Larix principis-rupprechtii* and *Pinus tabuliformis* plantations—two dominant and economically important timber species in Wangyedian and across China (Li et al., 2020). The study took advantage of the pre-existing forest stands, managed under different scenarios, to develop a stand growth dataset and a forest-level profit-function framework[4] for Wangyedian. The stands used in the study were selected from pure plantations of *L. principis-rupprechtii* and *P. tabuliformis* established on clear-cut land between 1973–1985 (Table 10). The initial planting densities were the same across different regimes—4,995 seedlings per hectare for *L. principis-rupprechtii* and 3,330 per hectare for *P. tabuliformis*. Growth and yield models were developed for each species under three distinct management regimes: (1) heavy thinning, involving multiple thinning events and removing over 60% of

[4] The forest-level profit-function framework is a modeling approach used in forestry economics to assess the profitability of forest management strategies at the "forest" level. Instead of analyzing just costs or revenues separately, it integrates biological growth models and economic variables to estimate net returns over a rotation period or management cycle.

Table 10: Stand data and thinning history for each forest management regime

Species	Regime	Reforestation[a] and plot information[b]			Thinning history						Stand information as of 2019			
		Year planted	Elevation (m)	Slope (°)	Year	Intensity (%)[c]	Removed volume (m^3/ha)	Stems before /after thinning (per hectare)	Mean DBH (cm)[d]	Mean height (m)[d]	Density (stems/ha)	Stand volume (m^3/ha)	Mean DBH (cm)[d]	Mean height (m)[d]
Larix principis-rupprechtii	Control	1977	1,370	17	*No thinning or other treatment in the control plots*						2,715	282.57	13.9	14.7
	Light thinning	1977	1,355	16	2011	35	65.95	2,875/1,869	11.9	12.8	1,692	252.58	16.3	15.7
	Heavy thinning	1974	1,260	16	1992	44	39.47	4,185/2,340	8	9.5	849	352.76	24.5	19.2
					1996	31	26.31	2,340/1,620	11.8	11.6				
					2000	21	18.23	1,620/1,275	14.6	14.3				
					2004	30	44.44	1,275/893	18.4	15.7				
Pinus tabuliformis	Control	1981	1,269	18	*No thinning or other treatment in the control plots*						1,962	220.82	14.7	13.4
	Light thinning	1985	1,236	20	2013	30	39.92	2,070/1,449	12.6	11.1	1,331	172.91	12.6	11.1
	Heavy thinning	1973	1,246	20	1995	44	33.48	2,760/1,562	9.2	7.1	752	214.39	21.7	17.4
					2001	26	20.4	1,562/1,159	13.8	9.1				
					2009	33	49.15	1,159/772	17.2	12				

Notes:

[a] The seedlings were all 2 years old, class I; the planting densities were 4,995 stems/ha for *L. principis-rupprechtii* and 3,330 stems/ha for *P. tabuliformis*.

[b] All the plots are on the eastern side of the hills.

[c] Thinning intensity is a percentage of stems removed.

[d] Mean DBH and height reflect the status before each thinning operation

stems; (2) light thinning, with a single thinning event and less than 30% stem removal; (3) a control group with no thinning. The stand data and thinning history of each management regime are shown in Table 10. The study then assessed how various combinations of thinning frequency and intensity, along with different timber product mixes, influenced overall forest productivity and profitability. This approach provided valuable insights into how active silvicultural intervention can optimize both ecological performance and economic returns in aging monoculture plantations.

The study found that high initial planting densities without thinning resulted in high mortality and slow growth rates, leading to unprofitable outcomes. Thinning operations increased both diameter and height of the retained trees, boosting the merchantable volume of large-diameter trees and thus the profitability and productivity. The individual tree volume and stand volume dynamics per hectare under specific management regimes are presented in Figure 17 and Figure 18. For both species, the individual tree volume was the largest in the heavy thinning regime, followed by the light thinning regime, and lowest in the control group. For example, at age 50, the volumes of individual *L. principis-rupprechtii* trees were, respectively, 0.47, 0.19, and 0.13 m^3 for heavy thinning, light thinning, and control. As for *P. tabuliformis*, the volumes of individual trees were 0.31, 0.25, and 0.18 m^3, respectively. These results illustrate that thinning can accelerate the growth of individual trees and positively affect volume.

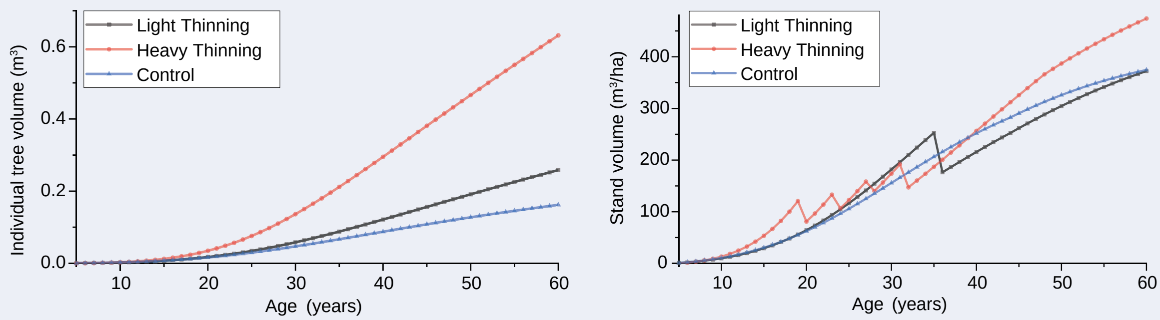


Figure 17: Individual tree volume (left) and stand volume per hectare (right) dynamics under specific thinning regimes for *Larix principis-rupprechtii*

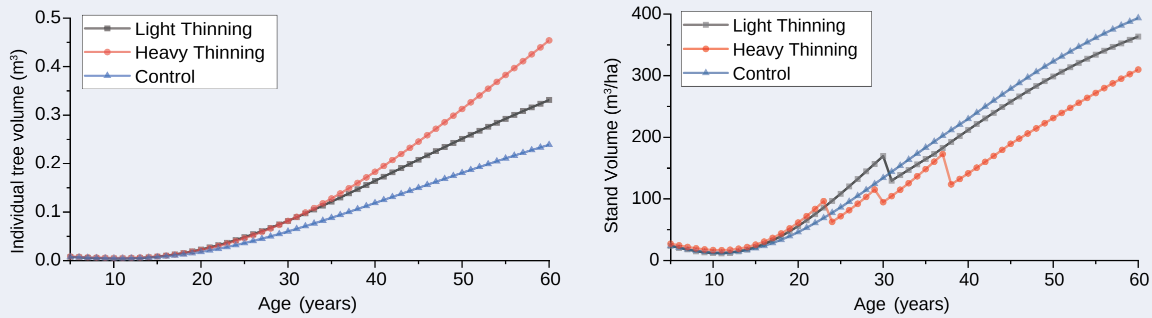


Figure 18: Individual tree volume (left) and stand volume per hectare (right) dynamics under specific thinning regimes for *Pinus tabuliformis*

With the incremental DBH and height growth induced by thinning, the merchantable volume ratio for both species also increased significantly in regimes of various degrees of thinning, compared to the control regime (Table 11 and Table 12). Again, at age 50, the heavy thinning regime of *L. principis-rupprechtii* could produce 55% sawtimber (ST) and 26% small-diameter-log (SDL) of the total merchantable volume of 313 m^3/ha (excluding bark). In comparison, the light thinning regime could generate 7% sawtimber and 70% small-diameter-log of the total merchantable volume of 236 m^3/ha, whereas the control regime could produce only 76% small-diameter-log of the total merchantable volume of 248 m^3/ha.

Table 11: Merchantable volume of *Larix principis-rupprechtii* under different regimes

Age (years)	Heavy Thinning		Light Thinning		Control	
	V_{ST} (m^3)	V_{SDL} (m^3)	V_{ST} (m^3)	V_{SDL} (m^3)	V_{ST} (m^3)	V_{SDL} (m^3)
10		8 (57%)		5 (55%)		6 (56%)
15		35 (65%)		18 (61%)		19 (62%)
20		58 (71%)		42 (66%)		41 (66%)
25		92 (75%)		81 (70%)		73 (69%)
30		134 (77%)		132 (72%)		111 (71%)
35	35 (18%)	111 (59%)		188 (75%)		151 (73%)
40	86 (34%)	117 (45%)		164 (76%)		188 (74%)
45	148 (46%)	112 (34%)		201 (77%)		219 (75%)
50	212 (55%)	101 (26%)	21 (7%)	215 (70%)		248 (76%)
55	269 (62%)	86 (20%)	53 (16%)	212 (62%)		271 (77%)
60	319 (67%)	72 (15%)	87 (23%)	205 (55%)		289 (78%)

Table 12: Merchantable volume of *Pinus tabuliformis* under different regimes

Age (years)	Heavy Thinning		Light Thinning		Control	
	V_{ST} (m^3)	V_{SDL} (m^3)	V_{ST} (m^3)	V_{SDL} (m^3)	V_{ST} (m^3)	V_{SDL} (m^3)
15		10 (38%)		7 (34%)		6 (31%)
20		36 (59%)		30 (54%)		23 (50%)
25		52 (72%)		73 (68%)		54 (62%)
30	2 (2%)	73 (77%)		128 (76%)		95 (71%)
35	27 (18%)	93 (63%)	10 (6%)	120 (73%)		140 (76%)
40	44 (31%)	73 (52%)	38 (18%)	134 (63%)	8 (4%)	173 (75%)
45	79 (41%)	82 (43%)	70 (27%)	143 (55%)	35 (12%)	189 (68%)
50	115 (50%)	84 (36%)	104 (35%)	146 (49%)	64 (20%)	199 (62%)
55	154 (57%)	83 (31%)	137 (41%)	146 (44%)	94 (26%)	203 (56%)
60	192 (62%)	80 (26%)	168 (46%)	143 (39%)	123 (31%)	204 (52%)

For *P. tabuliformis*, the merchantable volume of the heavy thinning regime at age 50 is 199 m^3/ha, with ratios for sawtimber and small-diameter-log being 50% and 36%, respectively. Meanwhile, of the 260 m^3/ha merchantable volume of the light thinning regime, 35% is sawtimber and 49% small-diameter-log; with a merchantable volume of 263 m^3/ha, the control regime could produce 20% sawtimber and 62% small-diameter-log. It is expected that a stand with a relatively higher portion of sawtimber, albeit a lower total volume, may well deliver a better economic performance, given the likely price differential between sawtimber logs and those with smaller diameters.

In this study, the optimal rotation age is determined economically when the net revenue, the difference between total revenue and total cost, reaches its maximum. In other words, the maximum net revenue is obtained when the marginal revenue equals the marginal cost (Li et al., 2020b). The optimal rotation age for *L. principis-rupprechtii* under heavy thinning is 48 years with a net revenue of $9,676 per hectare. The optimal rotation age for *P. tabuliformis* under the heavy thinning regime is 49 years with a net revenue of $1,937. For the light thinning regimes, the optimal rotation ages are 35 and 45 years, respectively, for *L. principis-rupprechtii* and *P. tabuliformis*, but the net revenues are much lower than those of the heavy thinning counterparts. The net revenues of the control regimes for both species are negative, meaning that it is unlikely the forest manager would make any profit if he/she does not pursue any thinning operation in the plantations. The net revenue dynamics of *L. principis-rupprechtii* and *P. tabuliformis* under three management regimes are presented in Figure 19 and Figure 20.

According to the current government technical regulations (SFA, 2005), the recommended final felling age for the *L. principis-rupprechtii* and *P. tabuliformis* plantations is 41 years, based on the age at which the mean annual volume increment peaks—often referred to as the ecologically optimal rotation age. However, findings from this study suggest that under heavy thinning regimes, the optimal rotation ages for *L. principis-rupprechtii* and *P. tabuliformis* should be extended to 48 and 49 years, respectively, 7–8 years beyond the current recommendation. This indicates that rotation age should not be treated as a fixed value; instead, it should remain adaptable and be adjusted according to variables such as site quality, planting density, thinning intensity, and other factors that influence forest growth dynamics and economic returns.

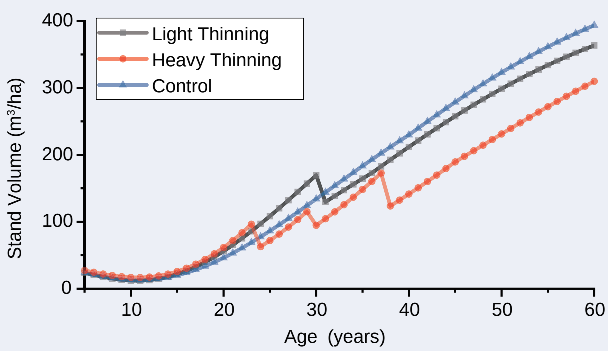


Figure 19: Net revenues and optimal rotation of *Larix principis-rupprechtii* in three thinning regimes

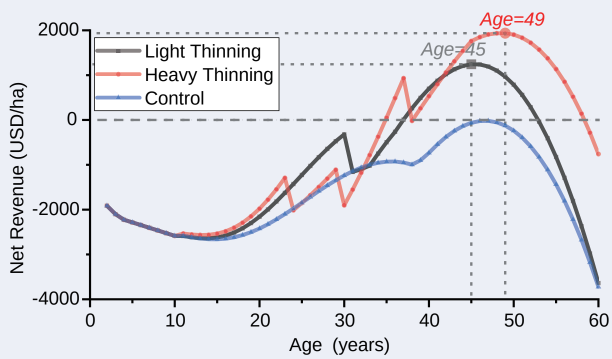


Figure 20: Net revenues and optimal rotation of *Pinus tabuliformis* in three thinning regimes

2.6 Close-to-Nature Forest Management (CNFM)

As mentioned in Section 2.1, Wangyedian Forest Farm faces challenges from past management practices that prioritized timber production, leading to simplified, even-aged monocultures with reduced ecological resilience. These forests are increasingly vulnerable to climate change and are less capable of delivering multiple ecosystem services. Close-to-nature forest management (CNFM) originated in Europe and is a specific strategy within multifunctional forest management that prioritizes ecological sustainability by mimicking natural forest dynamics (Box 5). It promotes components, structures, and processes characteristic of natural forests, thereby improving the diversity of tree species and structures, variation in tree size and development stages, and a range of habitats. It can be seen as a practical and ecologically sound solution for Wangyedian Forest Farm.

CNFM was first introduced to Wangyedian Forest Farm in 2011 by APFNet during Phase I of the Multifunctional Forest Management Project. It was later extended to Phase II to include additional areas of different ages. The primary goal was to demonstrate the transformation of monoculture plantations and low-quality natural secondary forests into high-productivity, mixed-species forests using CNFM techniques. There are different CNFM silvicultural techniques, such as target tree selection, cutting of competitor trees, assisted natural regeneration (ANR), enrichment planting with local species, and selective harvesting. By applying these techniques, the forest can be slowly converted into a multi-aged, diverse forest with a structural composition and species mix mimicking that of a natural forest in later successional stages.

To assess the long-term effects of CNFM, different trials were conducted applying CNFM to Chinese pine plantations (200 ha), larch plantations (74.3 ha), and natural secondary forests (100 ha). In Chinese pine (*P. tabuliformis*) and larch (*L. principis-rupprechtii*) plantations, treatment blocks from four age categories (young-growth, middle-aged, near-mature, and mature) were selected for the trial. In natural secondary forests, blocks in two age groups (middle-aged and near-mature) were chosen.

A total of 72 permanent sample plots were established, consisting of 27 Chinese pine, 27 larch, and 18 natural secondary forest plots, distributed across the top, middle, and bottom of the slopes on each hillside. Each circular plot has a radius of 13.82 m and an area of 600 m^2. All sample plots were surveyed and recorded in accordance with the sample plot inventory guidelines for close-to-nature forest management developed by this project. Some plots underwent a range of CNFM practices, for comparison, while some plots were managed using conventional thinning practices, and others were left untreated as controls.

2.6.1 Target Tree Management

The profitability of a commercial forest plantation is strongly influenced by the proportion of well-formed, large-diameter trees it contains. Unlike conventional thinning, which mainly removes small or poor-quality trees, or mechanical thinning, which follows a uniform row-based approach, target tree management focuses on cultivating high-value, large-diameter trees while minimizing disturbance to the overall stand. This approach, rooted in CNFM principles, identifies a limited number of well-growing, high-potential trees—called target trees or Z trees—for retention and growth, while selectively removing their direct competitors to optimize light, space, and resource availability.

What is Close-to-Nature Forest Management?

BOX 5

Close-to-Nature Forest Management (CNFM) is a multifunctional forest management approach that seeks to mimic the structure and dynamics of natural forests. By doing so, it supports biodiversity, resilience, and climate adaptation in managed forests and forested landscapes (Larsen et al., 2022).

Core Principles of CNFM

According to Larsen et al. (2022), CNFM is guided by the following seven principles:

1. Retention of habitat trees, special habitats, and dead wood.
2. Promoting native tree species as well as site-adapted non-native species.
3. Promoting natural tree regeneration.
4. Partial harvests and promotion of stand structural heterogeneity.
5. Promoting tree species mixtures and genetic diversity.
6. Avoidance of intensive management operations.
7. Supporting landscape heterogeneity and functioning.

Strategies for Transforming Monocultures with CNFM

CNFM can be used as an effective technique to transform monocultures into mixed forests with the following strategies:

- Diverse species planting – Instead of replanting monocultures, CNFM encourages planting a diverse mix of tree species. This diversity can include both coniferous and broadleaved species, which better mimics the natural composition of forests.
- Selective harvesting – CNFM promotes selective logging techniques over clear-cutting. By removing selected trees, a varied structure is maintained, ensuring that trees of different species and ages remain.
- Natural regeneration – Rather than relying solely on planting new trees, CNFM encourages natural regeneration. By creating gaps in the canopy through selective harvesting, sunlight can reach the forest floor, allowing seeds from a variety of tree species to germinate and grow.
- Promoting understory vegetation – CNFM pays attention to the understory vegetation layer, which is often suppressed in monoculture plantations. Encouraging the growth of diverse understory plants helps improve habitat quality for wildlife, enhances soil fertility, and contributes to overall ecosystem health.
- Long-term planning – CNFM involves long-term planning and monitoring to ensure that the forest ecosystem remains healthy and resilient over time. This may involve adaptive management techniques, where management practices are adjusted based on ongoing observations and research findings.

By employing these strategies, CNFM can effectively facilitate the conversion of monoculture plantations into diverse, mixed forests that are better able to withstand environmental challenges and support a wide range of plant and animal species.

Tree Marking and Target Tree Selection

CNFM aims to produce high-quality timber that commands premium prices, which requires more than just planting trees—it requires intentional management. Timber quality is shaped by four main factors: the tree's management history, site conditions, access to light and growing space, and genetics. While only growing space can be altered in the short term, selecting trees with a favorable history and genetics is essential. Therefore, early and accurate tree marking and selection are critical.

Target trees are typically long-lived, good-quality, and well-formed individuals that contribute to stand stability and productivity. Once selected, they are retained until maturity, unless damaged. Typically around 150 target trees per hectare (10%–15%) are marked for cultivation.

Competitor trees, on the other hand, are those that compete directly with target trees for light and growing space, usually trees with smaller crowns, poor form, or multiple stems. These are selectively removed, typically from two to three surrounding quadrants, to ensure target trees develop optimal crowns. Not all adjacent trees are competitors; only those that threaten the growth potential of a Z tree are removed to maintain a canopy density above 0.6.

Other target tree types may be retained for ecological reasons rather than timber production. These can include rare species, old or habitat-rich trees, or those that enhance visual or structural diversity. Depending on the forest's objectives, such trees may complement the Z trees, although the latter usually dominate in commercial settings.

Thinning Out Competitor Trees / Liberation Felling

Liberation felling, a key CNFM practice, refers to the selective removal of trees that hinder the development of target trees. It prioritizes the release of growing space for Z trees without compromising the overall canopy structure. This technique is applied with precision—only truly competitive trees are removed, preserving non-competing individuals even if they are of lower quality. This creates a heterogeneous stand structure and enhances stand resilience while promoting the targeted growth of valuable timber trees.

Competitor tree thinning or liberation felling should usually be carried out two to three times over the lifespan of each Z tree to ensure optimal growth. Final harvesting of a Z tree should occur once it reaches its target diameter or falls within the desired diameter range. This removal fully opens the canopy, releasing the developing understory and promoting regeneration. After a few years, a new cohort of Z trees can be selected to continue the cycle of targeted management (Figure 21 to 24).

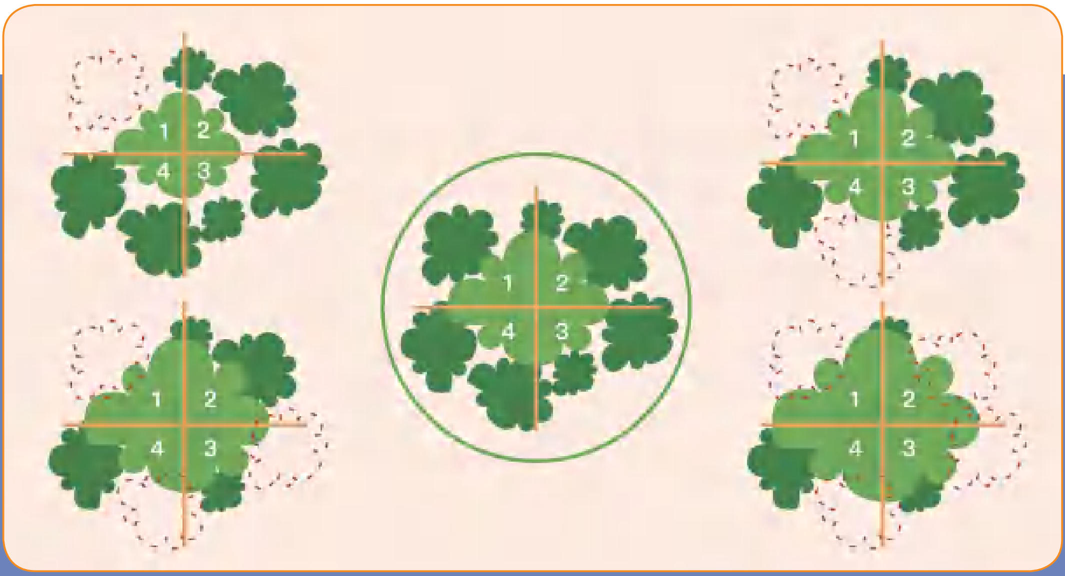


Figure 21: Progressive thinning across increasing quadrants around the central target tree. Top-left 1st thinning, top-right 2nd thinning, bottom-left 3rd thinning, and bottom-right 4th thinning

Figure 22: The impact on the canopy when thinning competitor trees around a Z tree (Photo: Wangyedian Forest Farm)

Figure 23: Target tree management of *Larix principis-rupprechtii*, the photos show the forest condition after the second, third, and fourth competition tree felling in order to reduce the forest density and promote the growth of target trees (Photo: Wangyedian Forest Farm)

Figure 24: The target diameter of *Larix principis-rupprechtii* is between 40–50 cm (Photo: Wangyedian Forest Farm)

2.6.2 Monoculture Transformation through Enrichment Planting

Traditionally, larch and Chinese pine monoculture plantations are clear-cut at the rotation age, approximately 40 years, and reforested with a new crop. Although this silvicultural system is considered to be a cost-effective method for timber production in the short term, the resulting monocultures present several ecological and silvicultural limitations, including low biodiversity, reduced resilience, and degraded soil conditions. To transition toward healthier mixed-species plantations, the absence of seed sources for late-successional or rare species often presents a barrier to natural regeneration and thus necessitates enrichment planting. As well as increasing diversity, enrichment planting can also help improve site and soil conditions, such as by using nitrogen-fixing species. It also offers both ecological benefits and economic opportunities, such as fruit production for short-term returns and the inclusion of high-value timber species for long-term returns.

In 2016, under Phase II of the Multifunctional Forest Management Project, target-tree-based thinning and different enrichment planting techniques were tested in 500 mu (33.33 ha) of mature Chinese pine (Figure 25) and larch plantations. This activity was implemented with two objectives: firstly, to demonstrate an alternative silvicultural practice to the existing clear-cutting system; and secondly, to demonstrate a gradual conversion of monoculture coniferous plantations into mixed forests through enrichment planting.

Before initiating the activity, a baseline survey of mature Chinese pine and larch plantations was conducted to gather data on the condition of the selected stands. A total of 12 permanent sample plots totalling 900 m^2 were established (sample plot baseline information is given below in Table 13).

Figure 25: Uneven-aged mixed Chinese pine forest established via enrichment planting and natural regeneration (Photo: Wangyedian Forest Farm)

Table 13: Summary information of sample plots of larch and Chinese pine plantations

Forest type	Plot No.	Age	Mean DBH (cm)	Dominant height (m)	Stand density (stems/ha)	Stand Basal Area (m^2/ha)	Stand Volume (m^3/ha)
Larch plantation	1.LCBD-1	47	24.1	19.6	533	24.4	139.8
	2.LCBD-2	47	23.6	20.0	756	33.1	188.8
	3.LCBD-3	47	22.8	17.4	633	25.9	149.0
	4.LCZY-1	47	22.1	20.7	656	25.1	140.1
	5.LCZY-2	47	18.9	17.6	1100	30.8	160.1
	6.LCZY-3	47	19.1	19.2	1111	31.8	169.4
Chinese pine plantation	7.YCBD-1	45	19.0	15.2	1400	39.6	143.1
	8.YCBD-2	45	20.5	15.1	856	28.3	106.5
	9.YCBD-3	45	18.6	14.8	1400	38.2	134.4
	10.YCZY-1	45	19.5	18.1	1233	36.6	133.7
	11.YCZY-2	45	20.4	15.4	1078	35.3	132.3
	12.YCZY-3	45	20.5	18.6	944	31.3	117.7

Note: BD stands for control plots, ZY stands for treatment plots.

Based on the baseline data, silvicultural treatments were designed and conducted under the guidance provided by forest experts from the Chinese Academy of Forestry. Accordingly, target-tree-oriented thinning and pruning were carried out to reduce competition and create gaps for regeneration. Enrichment planting was then carried out with 18,900 Mongolian oak seedlings (Table 14), in addition to seedlings of *Tilia mongolica* (Mongolian linden), *Sorbus pohuashanensis, Pinus koraiensis* (Korean pine), *Picea asperata* (Dragon spruce), and *Acer pictum* (Painted maple). Natural regeneration was also promoted to further enhance the species diversity.

Table 14: Operational activities for demonstration forests

Forest type	Compart-ment	Sub-compartment	Area (mu)	Silvicultural practice			
				Thinning (m^3)	Assisted natural regeneration	Interplanted seedlings (stems)	Pruning
Larch plantation	127	16	65	105.1	√	3900	√
Chinese pine plantation	134	14	250	419.9	√	15000	√

2.6.3 CNFM in Natural Secondary Forests

Assisted Natural Regeneration (ANR)

Natural secondary forests cover a small area of Wangyedian and are dominated largely by Mongolian oak (*Quercus mongolica*), poplar (*Populus davidiana*), Dahurian birch (*Betula dahurica*), and Asian white birch (*Betula platyphylla*). Although these forests are structurally more diverse, they often produce timber of inferior quality. In order to enhance productivity and yield high-value timber, CNFM practices were applied on an experimental basis.

Several blocks of natural secondary forest were selected for the application of CNFM techniques, including target tree selection, liberation felling, target tree pruning, and tending. In areas where natural regeneration was not sufficient, understory enrichment planting with Korean Pine (*Pinus koraiensis*), Korean spruce (*Picea koraiensis*), Mongolian oak (*Quercus mongolica*), and other economically valuable species was carried out to increase the overall value of the forest. Altogether 94,000 seedlings were planted.

In plots where natural regeneration was already sufficient, ANR was used to further promote natural regeneration. ANR techniques include soil disturbance (e.g. scarring), removal of competing vegetation (especially shrubs and grasses), prescribed burning, and controlled grazing.

The projects also support periodic assessments and monitoring of forest growth and health every 2–3 years. The results show that, through these interventions, forest biodiversity was enhanced, and structural complexity improved. Over time, these areas have been successfully transformed into well-structured, multi-layered, uneven-aged mixed forests that align with both ecological and economic goals (Figure 26).

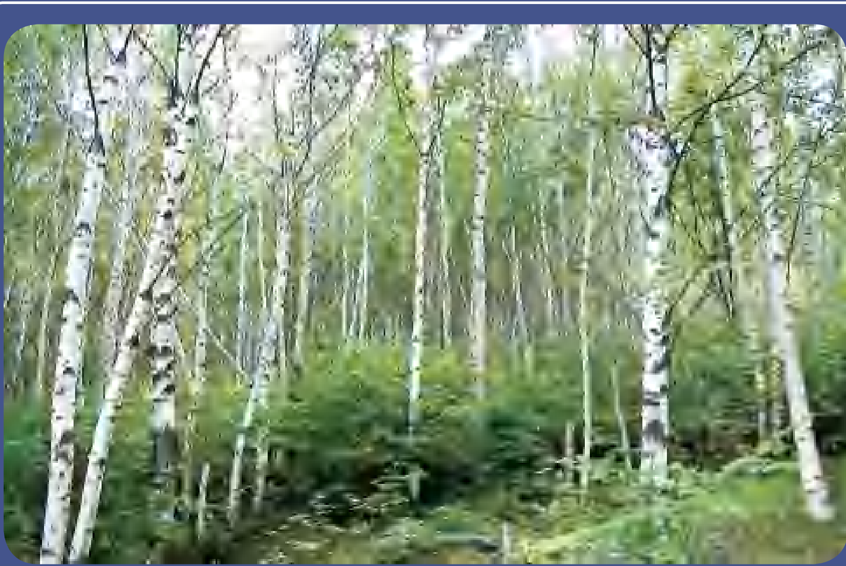


Figure 26: Before (top) and after (bottom) close-to-nature forest management of *Betula platyphylla* (Photo: Wangyedian Forest Farm)

2.6.4 Development of CNFM Regional Guidelines

Based on the practical experience from the Wangyedian projects, two regional guidelines were developed to promote CNFM of *Larix principis-rupprechtii* and *Pinus tabuliformis* plantations: *Technical Regulations for Close-to-Nature Forest Management of Larix principis-rupprechtii Plantations (DB1504/T 1017-2020)* and *Technical Regulations for Close-to-Nature Forest Management of Pinus tabuliformis Plantations (DB 1504/T1019-2020)*. The guidelines provide a systematic framework for site classification, target tree selection, mixed-species planting, and thinning across various stages of forest development. By integrating ecological principles with practical indicators, such as tree density and diameter targets, they support improvements in forest structure, biodiversity, and resilience. The guidelines have been adopted by the Chifeng Forestry and Grassland Bureau as regional standards and offer scalable reference for similar ecological zones in northern China, guiding sustainable silvicultural transformation of plantation forests.

2.7 Forest Fire Prevention

In China, governments and departments at all levels must establish and maintain forest fire prevention systems. As prescribed by the regulations on forest fire prevention, government authorities are required to establish, supervise, and manage forest fire prevention command centers. These centers are responsible for organizing, coordinating, and directing all forest fire prevention activities within their administrative regions, in accordance with the principle of “prevention first, effective suppression second”. Forestry administrations within local governments undertake the day-to-day management of the command centers, while the forest fire prevention activities themselves are under the responsibility of the local governments’ senior officials.

Although Wangyedian is more humid than other parts of Inner Mongolia, the winter season is still extremely dry, often resulting in a heightened risk of forest fires. To effectively prevent and control forest fires in Wangyedian Forest Farm, Phase I of the Multifunctional Forest Management Project supported the enhancement of the firefighting capabilities.

The project supported Wangyedian Forest Farm to install 30 km of fire lines and co-financed a forest monitoring system (Figure 27). Ten remote-controlled cameras were installed at strategic locations, capable of maintaining 24-hour surveillance of people and vehicles entering the Forest Park. This system helps to detect and prevent illegal logging or other activities that may harm the forest resources and infrastructure at the Farm. It also helps to monitor the incidences of forest fires for rapid response and remedial action.

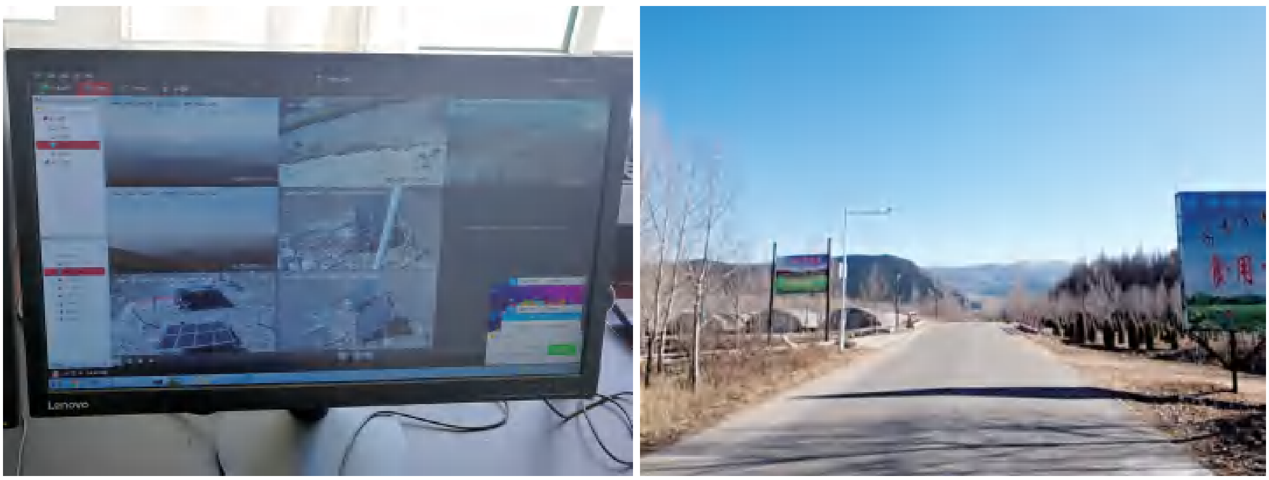


Figure 27: Remote-controlled video monitoring system (Photo: Wangyedian Forest Farm)

In 2012, representatives from local communities received training and were integrated into the forest ranger fire crews. Together, they formed six semi-professional firefighting and fire prevention teams. These teams are tasked with monitoring the entire Forest Farm for fire outbreaks and preventing illegal logging and other unauthorized activities. To equip the teams, APFNet procured a firefighting truck and 30 sets of wind-forced fire extinguishers (Figure 28).

Portable wind-forced fire extinguishers, also known as backpack fire extinguishers or wildfire backpacks, are specialized equipment used by firefighters to control and suppress forest and other types of wildfires (Figure 29). It consists of a backpack-like container that holds a fire-suppressing agent, along with a high-pressure air tank or pump system and a nozzle. It is a versatile and effective tool for controlling smaller-scale forest fires.

Fortunately, Wangyedian Forest Farm has not experienced a large-scale fire since 2003, when the largest recorded fire affected 13 ha of the Farm. Usually, fires stay below a hectare when they occur, thus only necessitating the use of smaller tools.

Figure 28: Firefighting training and the firefighting truck provided by the APFNet project (Photo: Ma Chenggong)

Figure 29: Wind-forced firefighting training (Photo: Wangyedian Forest Farm)

3

Genetic Conservation via Seedling Provision

3.1 Forest Nurseries

Wangyedian Forest Farm has long been considered a key forestry breeding base that provides high-quality planting material. The Multifunctional Forest Management Project Phase I supported the improvement of three nurseries at the Forest Farm, namely, Wujia Forest Nursery, Meilin Forest Nursery, and Dadian Forest Nursery. The nurseries were expanded from 5 ha to 10 ha, and irrigation systems and other related infrastructure were also improved. The 180 m^2 nursery management building and fence at the Dadian nursery were also renovated (Figure 30).

With financial and technical support from the project, the local company Dalaisen Seedlings Co., Ltd. established a new nursery and led seedling production in collaboration with local villagers in Xindian Village. This project significantly increased seedling production capacity while benefiting the villagers economically (refer to Section 4.5 for details).

The tree seedling species produced at the Forest Farm nurseries include larch (*Larix* spp., *Larix principis-rupprechtii*), Mongolian Scotch pine (*Pinus sylvestris* var. *mongolica*), Chinese pine (*Pinus tabuliformis*), Korean pine (*Pinus koraiensis*), spruce (*Picea mongolica*), Mongolian oak (*Quercus mongolica*), white birch (*Betula platyphylla*), and painted maple (*Acer pictum* subsp. *mono*).

To enhance the technical capacity of the Forest Farm nursery technicians, study tours were organized to Beijing Forestry University, Heihe City in Heilongjiang Province, Yanji in Jilin Province, and Qingyuan in Liaoning Province. These tours allowed technicians to inspect and study the latest technologies in raising high-quality forest seedlings.

Figure 30: Renovated nursery building and fence at Dadian nursery (Photo: Wangyedian Forest Farm)

3.2 Seed Production

Seed orchards are specialized plantations where trees are grown specifically to produce high-quality seeds for use in reforestation. These orchards are systematically designed and managed to ensure the production of genetically superior seeds that can produce trees with desirable qualities such as optimal growth, straight trunks, high-quality timber, and disease resistance (Figure 31). They are often established using a carefully selected range of parent trees that represent superior genetic characteristics (Box 6). Accordingly, seed orchards are valuable tools for genetic conservation in forestry, helping to preserve and propagate diverse and resilient tree populations that are essential for producing healthy offspring.

Mother trees

BOX 6

Mother trees, also known as parent trees, are mature trees that are selected due to their vigor, resilience, and superiority to produce seeds for regeneration. These trees are typically large, healthy individuals that have developed complex root systems and canopy structures. They often produce large quantities of seeds that can generate seedlings with desirable qualities.

Figure 31: Seedling production in the nurseries. Clockwise from top-left: Mongolian Scotch pine seedlings, staff members working in the nursery, irrigation systems, technical experts giving guidance (Photo: Wangyedian Forest Farm)

As previously mentioned, Wangyedian Forest Farm has long been considered an important center for producing high-quality planting material, including seeds. The Forest Farm established its first seed orchard—dedicated to larch species—in the 1970s. Today it manages seed orchards for three species with a total area of 45.8 ha: Changbai larch (*Larix olgensis*) 11.2 ha, Japanese larch (*Larix kaempferi*) 20.47 ha (Figure 32), and Scots pine (*Pinus sylvestris*) 14.13 ha.

In addition to seed orchards, a series of seed stands were also identified during the 1970s, totalling 217 ha. These designated forest areas have been specifically managed for the collection of high-quality seeds for reforestation and afforestation. The seed stands include: Japanese Larch (*Larix kaempferi*) 40 ha, Changbai Larch (*Larix olgensis*) 45 ha, North China Larch (*Larix principis-rupprechtii*) 92 ha, and Scots Pine (*Pinus sylvestris* var. *mongolica*) 39 ha.

To improve the seed orchards and seed processing, project funds were used to upgrade processing infrastructure, such as seed drying platforms and seed collection equipment. This increased seed production at the Forest Farm significantly, and the high quality of the seeds produced is well-recognized by users. As a result, Wangyedian Forest Farm was recognized as a key National Forest Seed Base by the former State Forestry Administration.

Figure 32: Seed orchard of Japanese larch (*Larix kaempferi*) (Photo: Wangyedian Forest Farm)

4

Livelihood Development

4.1 Rationale

In recent decades, the discourse surrounding multifunctional forest management has increasingly integrated social, economic, and environmental considerations. Central to this paradigm shift is the recognition that forests are not only valuable for their ecological functions but also crucial for supporting the livelihoods of millions of people worldwide (Cheng et al., 2017).

One of the primary rationales for integrating community livelihood development into multifunctional forestry is economic empowerment. Forests offer a range of goods and services that can be sustainably utilized to support local livelihoods. By engaging in activities such as cultivating and harvesting non-timber forest products (NTFPs), agroforestry, ecotourism, and sustainable timber harvesting, communities can access various economic opportunities. These alternative income streams can play a significant role in reducing poverty and enhancing resilience in forest-dependent regions (Cheng et al., 2017).

Community livelihood development should promote active participation from the community in decision-making processes and ensure that communities benefit directly from forest resources. This inclusive approach can be established through community co-management mechanisms, which can help build a sense of ownership and stewardship, reduce conflicts over resource use, and strengthen social bonds, leading to more resilient, equitable, and cohesive communities (Arts et al., 2017).

Community livelihood development can also play a crucial role in promoting environmental sustainability within forest ecosystems. By engaging local communities as stewards of the land, sustainable forestry initiatives can help prevent deforestation and conserve biodiversity. Through sustainable land-use practices, such as agroforestry and forest restoration, communities can enhance ecosystem resilience and ensure the long-term viability of forest resources for future generations (Chen et al., 2012).

4.2 Community Co-Management

To encourage greater involvement and equity, and to underpin the long-term sustainability of livelihood development initiatives, the APFNet project supported a community co-management pilot scheme. Community co-management, also known as community-based forest management, involves the collaboration between local communities, government, and other stakeholders in the management and conservation of forest resources. Involving communities in the management of the forests that they use can benefit both the forests and the local people themselves. Local communities often possess valuable knowledge and traditional practices related to forest management and silviculture. When integrated with scientific expertise, this knowledge can enhance silvicultural effectiveness by incorporating techniques that are well-suited to local conditions and ecosystems. This collaboration also provides opportunities for skill development and capacity building, empowering local people to actively participate in forest management activities.

Wangyedian Forest Farm launched the pilot co-management scheme in 2012 with Andangou village, a neighboring community of approximately 2,800 people in Meilin Town. The primary criterion for selecting this village was the community's high enthusiasm for participation. A team from the Chifeng Academy of Forestry conducted a detailed investigation using interviews, discussions, and questionnaires to identify how the community currently uses and manages the forest, explore potential livelihood development options, and assess community perceptions. Based on the findings and with further input from the community, a 10-year village-level co-management plan (2012–2022) was developed. The plan outlined joint activities such as resource protection, forest fire prevention, pest control, and the sustainable use of NTFPs, covering a total forest area of 1,200 ha. This area included the village's collective and individually owned forest lands, as well as areas within the Andangou village administrative boundary managed by Wangyedian Forest Farm as part of the state-owned forest farm.

To facilitate the implementation of the plan, a village co-management and coordination committee was established. This committee was responsible for coordinating decision-making between the village and the Forest Farm on forest-related issues. The village committee, including its directors, was directly elected by the villagers for a three-year term.

To help guide the villagers in the sustainable use of NTFPs, the co-management and coordination committee agreed to divide the forest area into four zones: (1) Fuelwood Collection; (2) Mushroom Cultivation; (3) Vine Collection; and (4) Nut Collection. Harvesting strategies and guidelines for each zone were drafted and explained to the community members. The site was divided into 12 management units based on the location of village groups (see Figure 11), with each unit assigned to a village team led by an elected leader. A joint protection mechanism was implemented in each zone to safeguard the area. As a form of reciprocity, the Forest Farm granted villagers free access to NTFPs in the designated state-owned areas in return for managing and protecting the land.

Five technical training programs were organized for community members of Andangou village during the farming off-season. Forestry experts from the Chifeng Academy of Forestry were invited to train the farmers on practical techniques such as reforestation and forest management, fruit tree pruning, collection and processing of NTFPs, forest ecology and community development, pest control, and forest fire prevention. Approximately 600 members of the community participated in the training.

An analysis of the shortcomings and obstacles encountered during the pilot scheme, along with an exploration of future opportunities, informed the development of a standardized co-management mechanism that can be replicated and scaled up in other areas.

4.3 Sustainable Use of Non-Timber Forest Products

Non-timber forest products (NTFP) refer to the wide range of renewable and non-renewable products that forests provide beyond timber. They play a crucial role in supporting livelihoods and maintaining cultural practices. Sustainable management and utilization of these products are essential for promoting the long-term health and resilience of forest ecosystems and the well-being of forest-dependent communities.

Wangyedian Forest Farm is rich in a variety of NTFPs, which the local community has been collecting and utilizing for many years. However, their traditional collection and utilization methods have historically lacked scientific guidance and considerations for sustainability.

APFNet projects supported the Forest Farm in launching several initiatives to understand the types and quantities of NTFPs available, to develop related livelihoods, and to help guide the community in more sustainable utilization of these resources.

Firstly, to understand the resources available, in 2012, an expert team from the College of Biological Sciences of Beijing Forestry University, in association with the technicians from the Chifeng Academy of Forestry and Wangyedian Forest Farm, conducted a comprehensive NTFP survey of the Wangyedian area (Figure 33).

Figure 33: NTFP survey (Photo: Ma Chenggong)

The survey documented a total of 627 vascular plant species across 88 families and 326 genera in the Forest Farm, among which, 12 plant species (including variants and deformations) were discovered as newly recorded in Inner Mongolia, and two of them were new records for China. The dominant families include Asteraceae, Poaceae, Rosaceae, and Fabaceae. Herbaceous perennials account for approximately 70% of all plant species, and while a few genera contain high species diversity, over half of the genera are represented by only a single species. Economically valuable NTFPs are abundant and include medicinal plants like *Codonopsis pilosula* (Dangshen), *Schisandra chinensis*, and various *Gentiana* species; edible wild vegetables including nettle, mountain lettuce, purslane, and fiddlehead ferns; as well as wild fruits and nuts such as hazelnut, apricot, and hawthorn.

In addition, a total of 162 wild macrofungi species were found, belonging to 2 phyla, 4 classes, 12 orders, 41 families, and 79 genera. The dominant families of these macrofungi were Agaricaceae, Russulaceae, and Polyporaceae. The survey documented a wide range of edible and medicinal fungi (Figure 34 and 35), including *Armillaria gallica, Tricholoma mongolicum, Hericium erinaceus,* and *Ganoderma* spp., as well as toxic species such as *Amanita* and *Inocybe* spp.. These fungi exhibit distinct ecological distributions, often associated with specific forest types such as pine or birch-oak stands.

Figure 34: *Armillaria gallica* (Photo: Wangyedian Forest Farm)

The survey findings were presented in an accessible brochure titled “Collection and Utilization of Non-wood Products in the Wangyedian Area” (Figure 36). For clarity, the plants were divided into six categories: food plants, medicinal plants, ornamental plants, edible mushrooms, medicinal fungi, and shrubs used for weaving. Alongside detailed descriptions, photographs, and information on local distribution, additional details were included on each species’ harvest seasons, processing methods, and uses, to encourage more scientifically guided and sustainable harvesting practices.

Figure 35: Wild nameko mushrooms (*Pholiota nameko*) (Photo: Wangyedian Forest Farm)

Figure 36: Non-timber forest resources brochure

In addition to the brochure, three training programs were held, targeting 18 administrative villages in Meilin Town. The programs covered a range of topics aimed at enhancing local knowledge and understanding of the various NTFPs in the area and ways to sustainably utilize them. Approximately 600 community members participated. During the sessions, it became apparent that seven varieties of wild medicinal fungi and five edible mushroom species were new to the participants.

To support the development of NTFP utilization in the Wangyedian area and to leverage the comprehensive information collected, the Wangyedian Area Non-timber Forest Products Utilization Plan was prepared under the technical guidance of the Chifeng Academy of Forestry. To enhance local livelihoods, promote ecological sustainability, and build a diversified forest economy, the Plan aimed to engage over 3,000 local households (30% of all households) in NTFP-related industries. The strategy focused on creating flagship NTFP production bases, establishing a competitive NTFP brand, and developing a professional workforce and cooperative enterprises to implement an "enterprise + base + farmer" model.

The plan established several initiatives, including a collaboration between the Forest Farm, a local mushroom processing factory, and the local community to develop mushroom cultivation (see Subsection 4.4.2). Target mushroom species include *Boletus*, *Russula, Clavulinopsis,* and *Ganoderma,* with many already being cultivated locally. In addition, it promoted understory cultivation of valuable plants (e.g. hazelnut and Mongolian oak), fern harvesting (notably fiddlehead fern and monkey-paw fern), and the development of wild edible and medicinal fungi. These efforts aim to position Wangyedian as a national production base for wild edible fungi and as a model for balancing conservation with economic development through NTFPs.

4.4 Mushroom Cultivation

4.4.1 Wild Mushroom Harvesting

Traditionally, residents living around the Wangyedian Forest Farm have collected wild mushrooms both for personal consumption and sale (Figure 37). Approximately 30% of the farmers were engaged in this activity to different degrees. Those who collected mushrooms on a commercial scale earned a minimum annual income of around CNY 4,000 (USD 571), with some of them earning more than CNY 10,000 (USD 1,428). Through the APFNet-supported NTFP survey and NTFP identification and utilization brochure, local farmers are now better equipped to identify edible mushrooms and avoid poisoning caused by misidentification. The initiative has also helped raise awareness among farmers about the importance of sustainable harvesting practices for wild mushrooms.

Figure 37: Wild edible mushrooms in Wangyedian Forest Farm (Photo: Ma Chenggong)

4.4.2 Collaborative Mushroom Cultivation

As part of the Wangyedian Area Non-timber Forest Products Utilization Plan to explore opportunities for enhancing community income, a partnership was formed between the community, the Forest Farm, and Fangxiang Edible Fungi Technology Development Co., Ltd. (Figure 38)—a leading mushroom processing enterprise in Inner Mongolia—to develop an economically viable industry based on residual forest resources.

The Forest Farm supplied more than one thousand tons of logging residues and fallen branches to the project partner (Fangxiang Edible Fungi Technology Development Co., Ltd.) as raw material to make cultivation media for growing mushrooms. In 2013, the enterprise chose 20 farmer households, each of whom expressed interest in building a polytunnel for growing mushrooms (Figure 39). They were provided with the necessary technology and training in the cultivation of edible mushrooms. After the training, they were each provided with cultivation media and 400,000 spawn bags of Nameko mushroom strain (*Pholiota nameko*, Box 7). In the first year, the farmers collectively produced approximately 500 tons of fresh mushrooms, and each farmer earned approximately CNY 20,000 (USD 2,857) by selling the mushrooms back to the enterprise for further processing (e.g. drying, salting, and freezing). The project was such a success that it was later expanded to include a total of 40 farmers and 80 greenhouses capable of producing 2,000 tons of fresh mushrooms per year.

Figure 38: The Fangxiang Edible Fungi Technology Development Co., Ltd (Photo: Ma Chenggong)

Figure 39: *Pholiota nameko* (left) and *Pleurotus ostreatus* (right) cultivated in the polytunnel managed by the local villagers in collaboration with Fangxiang Edible Fungi Technology Development Co., Ltd

Nameko mushroom (*Pholiota nameko*)

Pholiota nameko, commonly known as Nameko mushroom, is a popular edible fungus native to East Asia, especially Japan and China. It is easily recognized by its small, amber-brown cap covered with a natural gelatinous coating, which gives it a slightly slippery texture when cooked—hence its Chinese name “滑子蘑” (meaning “slippery mushroom”).

Nameko is cultivated commercially and used widely in soups, stir-fries, and hotpots. It has a mild, nutty flavor and a unique silky texture. Nutritionally, it is rich in dietary fiber, protein, vitamins (particularly B vitamins), and polysaccharides, which are believed to have immune-boosting and antioxidant properties. Nameko is both a culinary delicacy and a functional food in many Asian diets (Elkhateeb et al., 2024).

BOX 7

The rapid growth of fresh mushroom production by the farmers has boosted output at the processing factory. In response to this increased supply, the company expanded its operations and constructed additional processing facilities at Wangyedian Forest Farm, creating employment opportunities for more than 300 local community members. As of 2024, the factory operated three production lines dedicated to rapidly freezing, drying, and salting edible mushrooms, with an annual production capacity of 600 tons, encompassing both wild and cultivated mushrooms. The Fangxiang-branded products (Figure 40) are sold in many parts of the country, with an annual sales revenue exceeding CNY 3.6 million (USD 514,285).

Figure 40: Fangxiang mushroom products (Photo: Wangyedian Forest Farm)

4.4.3 Mushroom Cultivation in the Forest Understory

In 2012, Phase I of the Multifunctional Forest Management Project supported the initiation of agroforestry-style cultivation of edible and medicinal mushrooms, engaging local communities and taking advantage of Wangyedian Forest Farm's abundant understory space. The initiative proved highly successful and the cultivated area has since been expanded from the initial 0.67-ha demonstration site to over 230 ha of state-owned and collectively owned forest land.

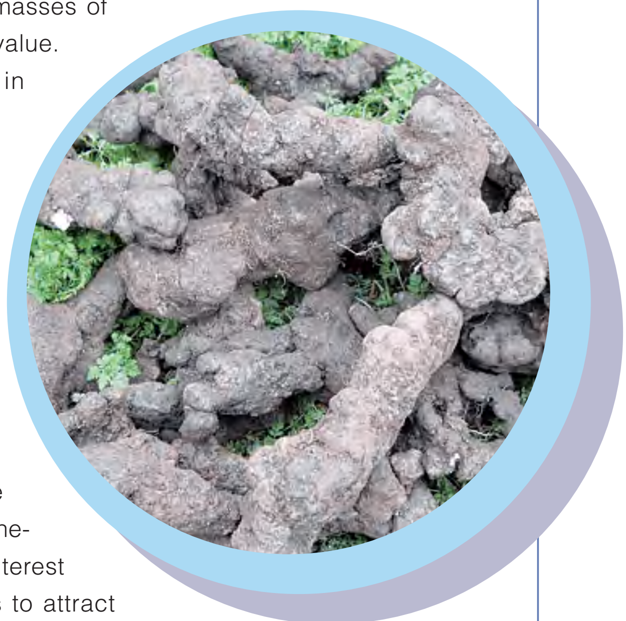
Cultivating Zhu ling (*Polyporus umbellatus*) in the forest understory

Fungi experts from Beijing Forestry University and the Chifeng Academy of Forestry were invited to inspect the forest area and provide guidance on suitable understory cultivation methods. Based on this investigation and the NTFP survey of the Wangyedian area, the wild medicinal mushroom variety Zhu ling (*Polyporus umbellatus*, Box 8) was selected. This species is known to thrive in nearby natural secondary forests and holds high economic value and market demand. As Zhu ling is commonly cultivated on hardwood logs, typically from trees such as oak or birch, two kinds of mixed white birch (*Betula platyphylla*) forests were selected for this trial, covering a total area of 0.67 ha: white birch mixed with larch, and white birch mixed with Chinese pine. The experiment was conducted both in autumn and the following spring to find out which season is more suitable for planting.

Zhu ling mushrooms (*Polyporus umbellatus*)

BOX 8

Zhu Ling (猪苓), scientifically known as *Polyporus umbellatus*, is a rare medicinal fungus that has been widely used in traditional Chinese medicine for centuries. It typically grows underground in symbiosis with the roots of hardwood trees such as oak, forming large, compact sclerotia—hardened masses of fungal mycelium that are the main source of its medicinal value. Above ground, it produces fruiting bodies that appear in umbrella-like clusters, hence the species name "umbellatus."



The fruiting bodies are pale to light brown and grow in dense bunches, usually at the base of trees in deciduous forests. While the fruiting part is occasionally eaten, it is the underground sclerotia that are primarily used for their therapeutic properties. In traditional medicine, Zhu Ling is known for promoting urination, reducing edema, and supporting kidney and bladder health. It is commonly used in herbal decoctions and powdered forms.

Modern pharmacological studies have begun to validate many of Zhu Ling's traditional uses, identifying potential immune-modulating, anti-inflammatory, and anticancer effects. As interest in natural remedies grows, *Polyporus umbellatus* continues to attract attention as both a valuable medicinal resource and a promising subject for further scientific research.

To cultivate Zhu ling in the forest understory, logs are first selected, ideally 10–15 cm in diameter, and are cut into 0.6–1 m lengths. After cutting to size, the bark is removed, and holes are drilled at regular intervals, spaced approximately 10–15 cm apart. *Polyporus umbellatus* spawn or mycelium-infused sawdust plugs, sourced from laboratory cultures or commercial suppliers, are inserted into the holes. The holes are then sealed with melted wax to prevent contamination and to retain moisture. Inoculated logs are laid horizontally in shallow trenches in the forest floor and partially covered with soil, leaving the tops exposed (Figure 41). Fruiting bodies typically begin to emerge from the inoculation points and form clusters near the surface of the soil within 6–12 months after inoculation, depending on environmental conditions and the quality of the spawn. *Polyporus umbellatus* is primarily valued for its underground sclerotia (hardened mycelial masses), and it takes 3–5 years for the sclerotia to fully mature and become suitable for harvest. Harvesting is done when they reach the desired size and maturity by cutting or twisting them from the logs.

Initial observations revealed that the growth of Zhu ling was highly satisfactory, so the cultivation area was expanded to 6 ha, and 5,000 inoculated logs were planted across the two forest sites. The areas were fenced and monitored by a designated trained individual. There remains potential to expand this activity, creating additional income for the local community and thereby improving their livelihoods.

Figure 41: Villagers planting *Polyporus umbellatus* in the secondary forests (Photo: Wangyedian Forest Farm)

Cultivating Red-Stropharia (*Stropharia rugosoannulata*) in the forest understory

Beginning in 2022, the APFNet project provided support to promote the understory cultivation of a high-value edible mushroom, *Stropharia rugosoannulata* (commonly known as Red-Stropharia or 赤松茸, Figure 42, Box 9). A 2-ha mature stand of *Larix principis-rupprechtii* was selected for demonstration. Prior to planting, shrubs and weeds were cleared, and the forest floor was leveled along contour lines into terraced or flat strips. The project team provided technical guidance, assisted in preparing the mushroom substrate (composed of sawdust, corncobs, sorghum stalks, and cow dung in a 3:3:3:1 ratio), procured high-quality mushroom spawn, and installed an irrigation system beneath the larch canopy. The selected mushroom strain is highly resilient, with a broad fruiting temperature range of 4–30°C (optimal 12–25°C). It can overwinter naturally and resume fruiting the following year until the substrate nutrients are exhausted. On average, each mu (0.067 ha) required a CNY 6,000 investment for substrate, spawn, and labour, with an expected yield of approximately 2,000 kg per mu per year. Depending on mushroom quality, market prices currently range from CNY 6 to CNY 20 per kilogram, which means the gross income for involved villagers is CNY 12,000 to CNY 40,000 per mu per year.

Figure 42: Harvesting *Stropharia rugosoannulata* in the larch plantation (Photo: Ma Chenggong)

Red-Stropharia (*Stropharia rugosoannulata*)

BOX 9

Stropharia rugosoannulata, commonly known as Red-Stropharia, Wine Cap mushroom, or 赤松茸 in Chinese, is a widely cultivated edible mushroom prized for its robust flavor, high nutritional value, and adaptability to diverse environments. It features a reddish-brown cap, a thick white stem, and a distinctive ring (annulus) on the stalk.

Native to Europe and North America but now cultivated globally, this mushroom thrives in temperate forest soils rich in organic matter and is particularly suited to understory cultivation beneath tree plantations like larch or pine. It grows well on decomposed agricultural byproducts such as sawdust, corncobs, and straw.

Nutritionally, Red-Stropharia is rich in protein, essential amino acids, fiber, and bioactive compounds that support immune health, metabolism, and antioxidant function. Its resilience, fast growth, and low production cost make it an ideal species for forest-based livelihood enhancement and agroforestry systems (Hu et al., 2021).

4.5 Collaborative Seedling Nursery

Under Phase I of the Multifunctional Forest Management Project, Wangyedian Forest Farm established a joint nursery in collaboration with the local community and a private company specialized in seedling production. The objective was to create additional income-generating opportunities for the community while catering to the increasing demand for tree seedlings.

The Forest Farm partnered with Dalaisen Seedling Company Ltd., which built a central tree nursery on suitable land belonging to community members (Figure 43). These community members received training in nursery management and seedling production; they automatically became shareholders because of their land rights and were also given priority for employment opportunities in the nursery.

By 2015, the nursery was annually producing 200,000 seedlings of Chinese pine and Korean spruce, which were sold across northern China, including Beijing, Tianjin, Hebei, Shanxi, Liaoning, and other areas in Inner Mongolia. The Forest Farm also purchases seedlings from the nursery when its own stock is insufficient for reforestation activities. In 2015, the annual sales revenue of the nursery was approximately CNY 3 million (USD 428,571), with a net profit of nearly CNY 600,000 (USD 85,714). The average annual profit for participating farmers was approximately CNY 20,000 (USD 2,857).

The nursery subsequently expanded from 5.33 ha to 10 ha, and the number of community shareholders also increased from 12 to 30 households. In terms of employment, annual labour hours have grown to about 8,000 person-hours.

Figure 43: Dalaisen Nursery (Photo: Wangyedian Forest Farm)

The success of the nursery project inspired nearby communities, and as a result, surrounding villages independently established 12 small private nurseries of their own, including Jingjiadian, Dongjuzi, Meilin, Gangzi, and Xiaomeilin villages. The Forest Farm provided the communities with technical guidance and training on seedling cultivation, nursery management, financial and general management, as well as market trend analysis. It also supplied improved seed varieties from its own seed orchards (see Section 3.2), and where necessary, the Farm coordinated seedling sales.

4.6 Silvopasture

Silvopasture, an age-old agricultural practice, involves the deliberate integration of trees and livestock. This agroforestry approach offers multiple benefits: trees provide shelter and forage for animals, improving their well-being, while also enhancing biodiversity, for example, through nutrient cycling, habitat diversity, and selective browsing. Silvopasture systems are typically managed to generate both short-term income from livestock and longer-term returns from timber.

People have engaged in silvopastoral practices in the Wangyedian area for many years, particularly within degraded forests that lacked specific management objectives. However, these historic practices were not carried out sustainably. To address uncontrolled grazing and overgrazing, the APFNet project supported the Forest Farm in introducing more sustainable forms of silvopasture within their forested areas.

Initially, two households were selected on an experimental basis, one to raise chickens and the other to raise Tibetan pigs. Each farmer was allocated funding to establish their pilot project and assume responsibility for it, including preventing forest fires, protecting the forest, and ensuring the sustainable use of the forest resources.

Mr. Li Jianyu, a resident of Dadian Village, was supported by the project in 2012 to raise chickens (*Gallus domesticus*) for meat production (Figure 44). Mr. Li received CNY 10,000 (USD 1,429) to construct a fence enclosing the foraging area, a small shed, and a breeding pen. Mr. Li was responsible for purchasing the 500 chicks and other inputs. After accounting for losses, 420 chickens were sold, generating a gross income of CNY 63,000 (USD 9,000) and a net income of CNY 24,000 (USD 3,429) after deducting the cost of chicks, medicines, and labour.


Figure 44: Rearing the chickens in the forest (Photo: Ma Chenggong)

Mr. Sang Daogou, another resident of Dadian Village, was supported in 2013 to raise Tibetan pigs (*Sus domesticus,* Figure 45). This breed was chosen for its small size (average adult weight <50 kg), ease of breeding (can produce up to two litters a year, each with about eight piglets), and natural diet of wild edible plants and fruits. They are a slow-growing breed, with a growth period of two years. Their meat is also popular in the Chinese market and in high demand. Mr. Sang received CNY 10,000 (USD 1,429) to set up a temporary shed and to purchase 100 piglets. The farmer was responsible for all other inputs. The approximate annual profit was CNY 50,000 (USD 7,142) from the sale of fully grown pigs.

Building on lessons learned from the pilot initiatives, the Forest Farm supported the establishment of the Lingguan Tibetan Pig Breeding Cooperative, a community-based animal breeding cooperative. The Forest Farm rented 500 ha of forest land to the cooperative for rearing 600 Tibetan pigs. The pigs fed from the forest undergrowth produced high-quality meat, which attracted a significantly higher price than fast-growing, industrially raised pigs. This method also substantially reduced feed costs, which made the project more profitable.

Figure 45: Raising Tibetan pigs at Wangyedian Forest Farm (Photo: Li Zhaochen)

4.7 Employment at the Forest Farm

In addition to enhancing and diversifying community livelihoods through NTFP initiatives, the Forest Farm directly addressed unemployment in Meilin Town by establishing a casual forestry workforce. One hundred individuals, including 40 women, were recruited under a team leader and signed labour contracts with the Forest Farm. The team received technical forestry training in various areas, including cultivation techniques, the planting of medicinal fungi, along with instruction in health and safety protocols. In addition to the training, the Forest Farm provided tools, safety equipment, and medical insurance for high-risk tasks such as timber harvesting. The team carried out a range of forestry operations at the Forest Farm, with each member earning an annual salary of approximately CNY 8,500 (USD 1,214).

In addition to this trained workforce, the Forest Farm provided additional seasonal employment opportunities such as timber harvesting and other silvicultural operations. The Meilin Valley tourism projects (see Chapter 5) also employ seasonal workers from the local area for day-to-day operations.

4.8 Energy-Saving Wood Stoves

Alongside income-generating activities, the project provided direct livelihood and environmental benefits by funding the conversion of 20 households' traditional wood stoves into energy-saving models (Figure 46). Improved cook stoves (ICS) burn wood more efficiently by optimizing combustion, reducing heat loss, and maximizing heat transfer to the cooking surface. The benefits are twofold: they save time and money by reducing the need to collect or purchase firewood, and they lower emissions by burning less fuel.

Figure 46: Traditional wood stove (left) and energy-saving wood stove (right) (Photo: Ma Chenggong)

An evaluation of monthly fuelwood usage among participating households showed a decrease from 16 kg to 11.5 kg, an energy saving of 28%. Furthermore, the investment cost of an energy-saving wood stove can be recovered within approximately 1.25 years due to reduced fuelwood consumption.

This pilot initiative created huge enthusiasm within the community. A subsequent survey found that more than 3,500 households have since adopted energy-saving wood stoves, resulting in an estimated annual reduction of 7,000 tons of fuelwood.

5

Developing a Regional Hub and Nature-Based Education Center

5.1 Rationale

Forest-based regional hubs are designed not only to benefit their respective sites and surrounding communities, but also to function as living laboratories that nurture innovation, particularly in sustainable forest management, and facilitate learning and knowledge exchange at local, national, and international levels.

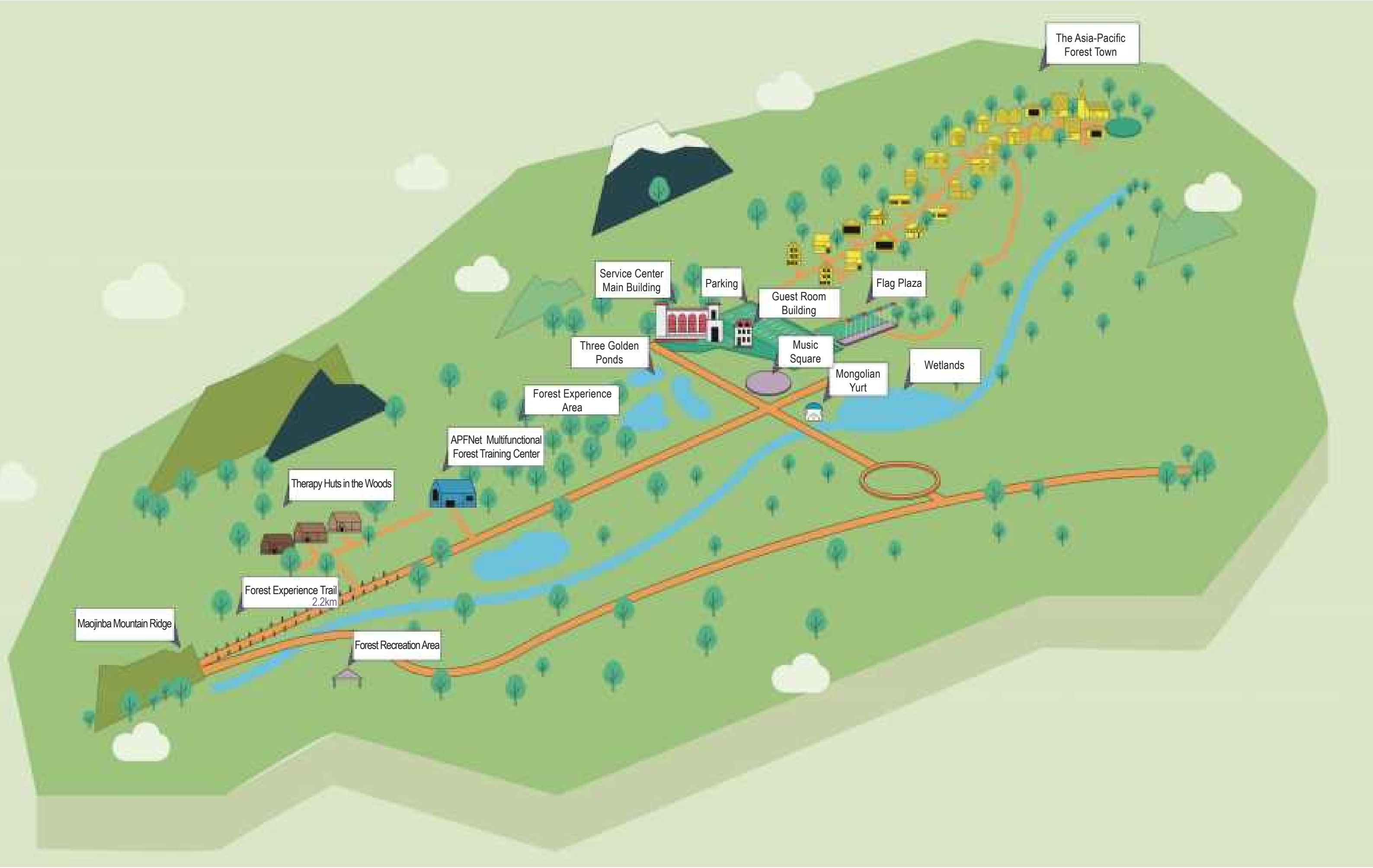
Wangyedian Forest Farm, building on decades of forest management and restoration since its establishment, has further benefited from APFNet's support in implementing successful multifunctional forestry demonstrations. These include science-based forestry planning, close-to-nature forest management, ex-situ genetic conservation, community co-management practices, nature-based tourism infrastructure, and a range of community livelihood development strategies. As a result, the Forest Farm was well-prepared and ready to be developed into a forestry demonstration and regional hub, offering valuable examples, insights, and learning opportunities for both local and regional stakeholders.

Figure 47: The APFNet Multifunctional Forest Management Demonstration and Experience Base (Photo: China Pictorial)

In 2018, APFNet started the Wangyedian Forest Experience Base Project, aimed at establishing a multifunctional forestry base to integrate education and training with leisure and entertainment, ecological and cultural displays, and other functions. It is part of APFNet's broader strategy to promote and facilitate sustainable forest management, forest restoration, and enhance livelihoods in an integrated manner. The base comprises the APFNet Multifunctional Forest Experiment and Training Center, serving as an outreach and environmental education hub; a forest experience zone, recreation area, and thematic trails for showcasing best forest management practices and conducting nature-based learning; as well as a service center and the Asia-Pacific Forest Town, which offer accommodation and facilities for conferences and meetings.

APFNet has supported the establishment of three such forest-based regional hubs in China. While the Wangyedian base, officially known as the APFNet Multifunctional Forest Management Demonstration and Experience Base (Figure 47 and 48), is focused on multifunctional forest management in northern temperate forests, the Pu'er base in Yunnan Province and the Hainan base in Hainan Province have focused on subtropical and tropical forests, respectively. These bases are equipped with accommodation, conference rooms, educational installations, and forest experience areas, creating an enabling environment for environmental education, scientific research, high-level policy dialogue, and nature-based tourism.

Figure 48: Guide map of APFNet Multifunctional Forest Management Demonstration and Experience Base



5.2 Environmental Education

At the core of the regional hubs is a commitment to environmental education. Nature-based education can cultivate a sense of responsibility for the natural world. By illuminating the connections and value of ecosystems and biodiversity, it helps individuals understand how to take meaningful action and inspires them to protect the environment.

The APFNet Multifunctional Forest Management Demonstration and Experience Base has been developed to serve as a dynamic hub for immersive environmental pedagogy. The site welcomes visitors of all ages, including primary and secondary school groups, families, individuals, and specialist interest groups. Through interactive nature trails, forest therapy circuits, observation decks, wildlife tracking simulations, and citizen science monitoring stations, the site blends education with recreation, fostering greater engagement and understanding of the natural world (Figure 49).

Figure 49: Nature education
(Photo: Wangyedian Forest Farm)

Nature education-related facilities at the Base supported by APFNet-funded projects include:

- **The APFNet Multifunctional Forest Experiment and Training Center**

The APFNet Multifunctional Forest Experiment and Training Center was established through Phase I of the Multifunctional Forest Management Project and opened to the public in 2015 (Figure 50). It serves as an outreach and educational facility to share best practices and lessons learned. In the training center, a 200 m^2 nature education room was built and is designed to be multi-purpose, serving as a conference room as well as an exhibition hall displaying information on the development of APFNet, Wangyedian Forest Farm's approach to multifunctional forestry development, and forestry science.

The displays are designed to help people learn more about forest management practices, understand the dynamics of forest ecosystem succession, and appreciate the profound impact forest ecosystems have on human life. Ultimately, the displays seek to broaden public awareness of the forest ecosystems and build support for sustainable development.

Figure 50: The Wangyedian APFNet Multifunctional Forest Experiment and Training Center (bottom) and the nature education room inside the Training Center (top) (Photo: Li Zhaochen)

- **An Educational and Therapeutic Forest Experience Trail**

A 2.2 km forest trail was transformed into an educational and therapeutic forest experience trail (Figure 51). The trail helps tourists understand forests at a deeper level, with installations covering five thematic areas: (1) demonstration of reforestation techniques; (2) biodiversity corridors highlighting keystone species; (3) NTFP harvesting; (4) forest therapy areas with phytoncide monitoring displays; (5) exhibits comparing monoculture plantations to mixed multi-strata forests.

Installations are designed to be fun and interactive. For example, to help children understand forest biodiversity, homes of underground animals were artfully recreated in the playground for children to explore. To learn about trees, games were included, such as guessing trees by their bark.

The trail also utilizes natural materials (e.g. wood and stone) and ecologically sensitive construction principles to reduce impact on the natural environment, encouraging a more immersive forest experience.

- **The Arboretum**

The 18.9-ha arboretum serves as a living laboratory, showcasing 32 native species. Informative signage guides visitors through successional growth stages, plant taxonomy, ecological relationships, and phenological traits.

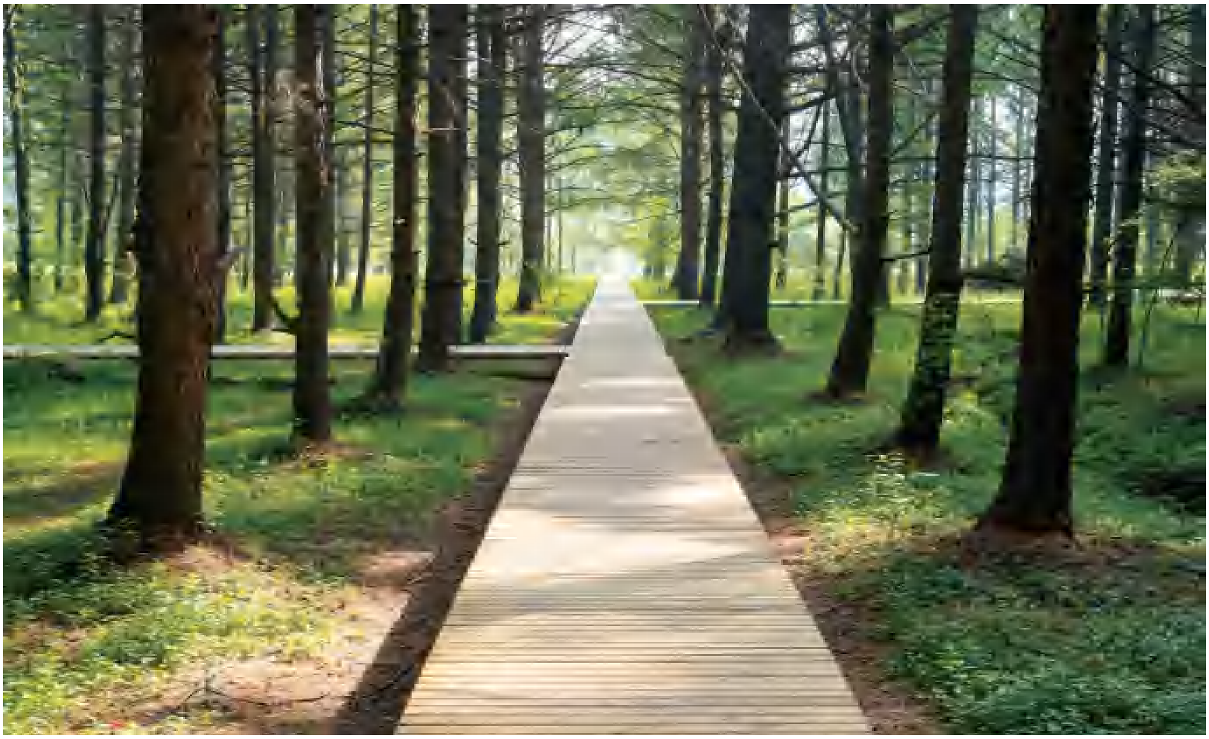


Figure 51: Educational forest installation (top) and the forest trail under the larch plantation forest (bottom) (Photo: Wangyedian Forest Farm)

5.3 Scientific Research

The research opportunities and facilities at Wangyedian Forest Farm have established it as an important research hub for forestry scholars, attracting academics from institutions such as Beijing Forestry University and Nanjing Forestry University. During the implementation of the APFNet projects, researchers from Beijing Forestry University, Renmin University of China, and the Chinese Academy of Forestry collaborated with APFNet and the Forest Farm to establish silvicultural study plots and field laboratories, enabling scientific study of forest management measures implemented at the Farm.

The site has supported numerous academic studies, including student theses, research projects, and peer-reviewed publications. Of the peer-reviewed articles, many focus on the effectiveness of Close-to-Nature Forestry Management (CNFM), contributing to the growing body of scientific literature that validates its ability to enhance biodiversity while sustaining timber productivity in temperate ecosystems. Empirical analysis from Wangyedian Forest Farm shows that CNFM could considerably increase biodiversity with almost no negative influence on timber productivity. A selection of peer-reviewed academic articles resulting from research carried out at the Forest Farm is summarized below.

I. Effects of close-to-nature management on water conservation capacity of the artificial *Pinus tabuliformis* forests of different ages (Zhao et al., 2017)

This study aimed to understand the influence of CNFM on the water-holding capacity of *Pinus tabuliformis* plantation forests of varying ages by measuring moisture retention in the forest's litter and soil layers. The results showed that when compared to unmanaged or conventional management practices, *Pinus tabuliformis* forests under CNFM:

-had higher litter volume and higher water-holding capacity in this layer,

-had greater soil porosity and volume,

-and had higher overall water-holding capacity:

CNFM: 1,662.42 t/ha,

Unmanaged: 1,526.12 t/ha,

Conventional: 1,379.18 t/ha.

In conclusion, the research found that CNFM can increase soil water-holding capacity in *Pinus tabuliformis* plantation forests.

II. Effect evaluation of close-to-nature management on the health of the artificial *Larix principis-rupprechtii* forest (Zhao et al., 2017)

This study investigated the effect of CNFM on four indicators of forest health in *Larix principis-rupprechtii* plantation forests: productivity, community structure, stand resilience, and soil quality. The study found that across all four indicators, forest health under CNFM was better than in forests under no management or conventional management practices. The study provides a theoretical basis for the strategies and management of the *Larix principis-rupprechtii* plantation forests.

III. Influence of close-to-nature management on the species diversity of shrubs and herbaceous plants in artificial Larix principis-rupprechtii forests (Wang et al., 2017)

This study focused on the effect of CNFM on the diversity and species richness of shrub and herbaceous plants in *Larix principis-rupprechtii* plantation forests. Measurements were taken from research plots in unmanaged, conventionally managed, and CNFM forest stands in 2013 and again in 2016. The results indicated that CNFM enhanced shrub and herbaceous species diversity and richness in young, middle-aged, and near-mature forests.

IV. Close-to-nature forest management measures for *Pinus tabuliformis* plantations (Ma et al., 2018)

This study analyzes the fundamental principles and main measures of CNFM. Based on an analysis of CNFM techniques, such as target tree management, competitive tree thinning, and assisted natural regeneration on *Pinus tabuliformis* sample plots, best practices of the management measures for three age classes (young, middle-aged, and near-mature forests) of the plantations were proposed. The study provides a sound basis for the management of the *Pinus tabuliformis* plantations.

V. Resource investigation and diversity of macrofungi in Wangyedian Forest Farm of Inner Mongolia, northern China (Yu et al., 2013)

This study systematically investigated the species diversity of macrofungi at Wangyedian Forest Farm in 2012. More than 350 specimens were collected from four types of forest (pine plantations, larch plantations, natural secondary forests, and plantations with natural regeneration) across the Forest Farm. The analysis of the samples found 162 species belonging to 2 phyla, 4 classes, 12 orders, 41 families, and 79 genera. The diversity and abundance of macrofungi were highest in natural secondary forests, followed by larch plantations, pine plantations, and, lastly, plantations with natural regeneration. Additionally, the study identified twelve species as new to Inner Mongolia and two species as new records in China.

VI. Evaluation system building of multifunctional forestry based on "Three Functions": APFNet project as an example (Chen et al., 2015)

This study analyzed the interactions between the ecological, economic, and social functions of multifunctional forestry. The ultimate objective of this analysis was to develop an evaluation system based on the three functions to effectively assess the status, development trends, and accomplishments of multifunctional forestry strategies and to make recommendations for improvements.

VII. The evaluation of carbon footprint from the operation of the Forest Farm and carbon storage by forest resources: Based on the Wangyedian Forest Farm in Chifeng of Inner Mongolia (Ke et al., 2013)

This study calculated the carbon emissions of the Wangyedian Forest Farm using local emissions data and the IPCC carbon accounting methodology. It analyzed the impact of each activity and calculated the current carbon storage across the Forest Farm. It calculated the total annual carbon emissions were 1,189.3 t CO_2, and the total carbon stock was 4,336,626.3 t CO_2. The study recommended that Wangyedian Forest Farm reduce carbon emissions and improve energy efficiency by: minimizing resource waste; promoting energy-saving behaviors among staff; adopting clean energy sources such as solar and biogas; and reducing emissions from forestry operations by using biological pest control and organic fertilizers. Additionally, it advised improving forest quality by transitioning to close-to-nature mixed forests; and exploring voluntary carbon offset projects, such as the China

Certified Emission Reduction Scheme (CCER), to quantify and monetize carbon sequestration benefits while neutralizing its carbon footprint.

VIII. Productivity and profitability of *Larix principis-rupprechtii* and *Pinus tabuliformis* plantation forests in Northeast China (Li et al., 2020)

This study analyzed the productivity and profitability of *Larix principis-rupprechtii* and *Pinus tabuliformis* plantations at Wangyedian Forest Farm under three management regimes with varying thinning intensities: heavy thinning, light thinning, and control. Results showed that high initial planting densities without thinning led to high mortality and slow growth rates, resulting in unprofitable outcomes. Thinning operations increased both diameter and height growth of the retained trees, boosting the merchantable volume of large-diameter timber and thus the profitability and productivity. The optimal rotation ages under heavy thinning were estimated to be 48 years for *Larix principis-rupprechtii* and 49 years for *Pinus tabuliformis* plantations, 7–8 years longer than the current management regulation recommendations. Productivity per hectare per year for *Larix principis-rupprechtii* in the heavy thinning regime doubled to 8.21 m^3. For *Pinus tabuliformis*, the thinning treatments increased productivity gains from 5.1% to 7.9%. The study concluded that constraints imposed by government regulations on thinning near-mature stands could significantly reduce profitability and productivity.

5.4 Hosting Forestry Dialogues and Technical Exchanges

Through infrastructure development supported by APFNet initiatives, Wangyedian Forest Farm has successfully established itself as a base for high-level international forestry dialogues, technical exchanges, and workshops. Demonstrating this role, between May and August 2023, following recovery from the COVID-19 pandemic, the Forest Farm hosted approximately 20 meetings and conferences, welcoming over 5,000 participants in just four months. It has also welcomed more than 50 international delegates from over 30 economies, including the US, Canada, Australia, Thailand, and Malaysia. The following are some of the main events organized at the Forest Farm.

High-level dialogues

- The *Symposium on Asia-Pacific Forestry Cooperation* under the Belt and Road Initiative was convened on July 22, 2019, to advance multilateral forestry partnerships (Figure 52). This ministerial-level dialogue also facilitated technical exchanges on sustainable timber supply chain development and transboundary ecological corridor planning, with particular focus on implementing the UN Strategic Plan for Forests 2017-2030 through regional collaboration mechanisms.

Figure 52: The Symposium on Asia-Pacific Forestry Cooperation under the Belt and Road Initiative (Photo: Liu Chengye)

- The *Third Meeting of Ministers Responsible for Forestry in Greater Central Asia* was held from September 11 to 14, 2023, hosted by NFGA and APFNet (Figure 53). Over 70 high-level forestry policymakers, practitioners, researchers, and representatives from NGOs and the private sector attended the meeting. It provided updates on national forest policies, regulations, development planning, and desertification control in the region; shared forestry cooperation priorities; and explored how to further promote bilateral and multilateral cooperation and adopt the *Action Plan for Greater Central Asia Forestry Cooperation Mechanism (2023–2025).*

Figure 53: The Third Meeting of Ministers Responsible for Forestry in Greater Central Asia (Photo: Liu Zhongyou)

Technical exchanges and workshops

- *The 2016 Inner Mongolia Sustainable Silviculture Workshop* convened 40 provincial-level forestry professionals for a technical review of APFNet-developed multifunctional forestry models (Figure 54). Participants conducted field evaluations of experimental silvicultural plots with particular focus on integrated agroforestry systems.
- From September 5 to 7, 2017, a diplomatic delegation comprising representatives from the embassies of ten APFNet member economies in China conducted a technical visit to Wangyedian Forest Farm (Figure 55). The delegation toured multifunctional forestry demonstration plots and participated in policy dialogues on sustainable forest governance frameworks.
- The International Conference on Smallholder Forestry and Forestland Fragmentation: Eurasian Policy Synergies (2018), jointly convened by the FAO, NFGA, APFNet, and Renmin University of China, established a multilateral dialogue addressing smallholder-driven forest fragmentation. Delegates from Austria, Cambodia, China, Germany, Portugal, South Korea, Sweden, and Thailand presented case studies on innovations in landscape governance, focusing on policy instruments to reconcile ecological connectivity with rural livelihoods.

Figure 54: Field visit during the Inner Mongolia Sustainable Silviculture Workshop in 2016 (Photo: Ma Chenggong)

Figure 55: A diplomatic delegation of APFNet member economies (Photo: Ma Chenggong)

- The Forest Rehabilitation in China & APFNet Project Achievements Sharing Workshop (2018) brought together 28 technical experts representing six different APFNet-funded initiatives (Figure 56). The event facilitated cross-project knowledge exchange through presentations on the initiatives, including:
  - Ecological restoration techniques for degraded forest landscapes.
  - Integrated desertification control methodologies.
  - Adaptive watershed governance frameworks.
  - Low-impact ecotourism operational standards.
  - Multifunctional silvicultural systems.
  - Sustainable forest management certification protocols.

Figure 56: Forest Rehabilitation in China & APFNet Project Achievements Sharing Workshop (Photo: Wangyedian Forest Farm)

- *The Sino-Thai Forestry Education Symposium: Emerging Paradigms and Institutional Synergies* (2018) was co-hosted by APFNet and Beijing Forestry University to promote dialogue and build cooperation among forestry universities in China and Thailand. Through structured workshops, the forum formulated 12 actionable recommendations for transnational curriculum development and joint research initiatives, particularly in sustainable forest product value-chain optimization.
- From July 23 to 31, 2016, Wangyedian Forest Farm curated a technical exchange program for forestry administrators from five Central Asian economies, featuring field inspections of sustainable timber processing facilities and silvicultural demonstration sites. The study mission included comparative analyses of China's forest certification mechanisms and regional afforestation techniques applicable to arid ecosystems.
- From August 25 to 29, 2024, the international training workshop on *Vegetation Rehabilitation and Sustainable Development in Arid Regions of Mongolia* was held at Wangyedian Forest Farm. The workshop aimed to enhance collaboration and knowledge sharing between China and Mongolia on vegetation rehabilitation and sustainable development in arid areas. Ten management and forestry technicians from Erdenet Mining Corporation SOE of Mongolia participated in the training, and a team of renowned experts in forestry and desertification control in Inner Mongolia was invited to share their expertise. The training workshop was sponsored by APFNet through its Greater Central Asia Forestry Cooperation Mechanism (GCA-FCM), hosted by the Forestry and Grassland Administration of Inner Mongolia, and organized by the Forestry Academy of Inner Mongolia.

5.5 Nature-Based Tourism

Nature-based tourism offers a wide range of benefits and is formally defined by the United Nations World Tourism Organization (UNWTO) as tourism that is primarily motivated by the desire to observe and appreciate natural environments (UNWTO, 2024). In addition to raising environmental awareness among visitors, the financial incentives generated by nature-based tourism encourage local communities to engage in conservation efforts and protect ecosystems. It supports alternative, sustainable livelihoods and reduces dependence on extractive activities such as unsustainable timber harvesting. However, success depends on careful implementation and adherence to environmental sustainability principles and frameworks. Poorly managed tourism can have negative impacts, for example, habitat fragmentation caused by infrastructure development, disturbance of sensitive areas (e.g. nesting sites), mismanaged waste, or cultural commodification.

With careful planning, respect for the forest's carrying capacity, collaboration with the local community, guidance from environmental and sustainability experts, and support from APFNet, Wangyedian Forest Farm has developed into a model site for nature-based tourism.

5.5.1 Tourism Potential of the Wangyedian Forest Farm Area

Wangyedian Forest Farm's rugged topography, rich seasonal biodiversity, and expansive natural secondary forests make Wangyedian Forest Farm a prime location for nature-based tourism. In spring, montane meadows burst into color, followed by verdant summers where dense foliage and multi-layered canopies reach up to 35 meters high. Autumn brings spectacular foliage, painting the landscape in vivid hues before fading into monochromatic winter, with frost-rimmed conifers contrasting against the snow (Figure 57). The seasonal changes, combined with the diverse landscape, make this Forest Farm rich in faunal biodiversity, with observational success rates surpassing regional baselines. The site's diverse topography also makes this site ideal for adventure tourism, such as hiking and biking.

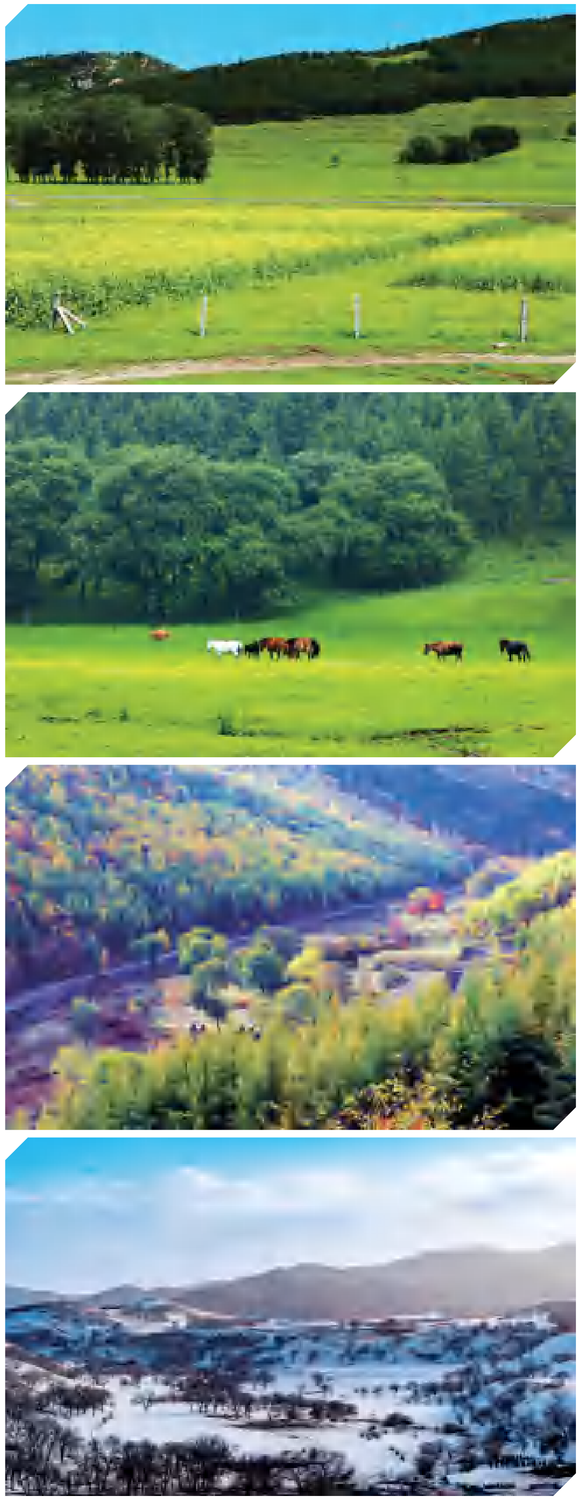


Figure 57: Spring, summer, autumn, and winter at Wangyedian Forest Farm (top-bottom) (Photo: Wangyedian Forest Farm & Li Zhaochen)

In terms of accessibility, the Forest Farm is located 310 km away from Beijing along the Daguang Expressway, which is ideal for visitors from the highly populated Beijing-Tianjin-Hebei urban region. In terms of public transport, the nearest train station is an hour's drive away; however, there are no local bus services.

5.5.2 Tourism Investments Prior to APFNet Projects

In 2007, prior to the APFNet-funded projects, Wangyedian Forest Farm began developing nature-based tourism. Two public-private partnerships with specialised ecotourism developers brought significant financial investments in tourism infrastructure. The first, with Beijing Meilin Zhengda Investment Group, provided CNY 1 billion (USD 143 million) to establish the Meilin Valley International Championship Ski Resort, which opened in 2011, alongside 15 km of hiking trails, equestrian circuits, and mountain bike paths. The second, with Golden Century Group, resulted in the CNY 2.3 billion (USD 329 million) Forest Leisure Resort Complex (Figure 58), featuring an ecological conservation zone, a forest ecotourism area, a sustainable NTFP production area, an administrative and residential zone, and Northeast Asia's largest indoor ski facility (82,000 m^2).

Wangyedian Forest Farm also created strategic alliances with Chifeng's tourism network, which helped implement real-time booking systems and management platforms, increasing visitor numbers while remaining within ecological carrying capacity limits.

Figure 58: Photos of the integrated recreation zone (clockwise from top left): a suspension bridge in the secondary forest, the entrance to the forest experience area, a wooden bridge in the forest, and a cabin in the woods (Photo: Wangyedian Forest Farm)

5.5.3 Tourism Infrastructure Developed by APFNet

In addition to the nature education facilities and to complement existing eco-tourism infrastructure, APFNet project funding has supported Wangyedian Forest Farm in enhancing its nature-based tourism offerings as part of the development of the regional hub. The following APFNet-funded improvements were made to enhance the Forest Farm's tourism facilities:

- In 2016, as part of Phase II of the Multifunctional Forest Management Project, a new 48-ha leisure area was developed approximately 5 km from the Multifunctional Forest Experiment and Training Center. This leisure area includes various recreational facilities, such as nature trails, cabins, pavilions, picnic areas, signboards, and information displays, as well as play areas for children. In 2017, a drawbridge and a stone bridge were also constructed, reflecting local architectural styles. Additionally, a 3 km access road was built, and water and electricity supplies were installed.
- A 1.5-meter-wide, 280-meter-long wooden boardwalk was built in 2021 under Phase III of the project, within the Japanese larch forest between the training center and the service center (Figure 59). Six 15-meter-long branches extend from both sides of the main track, each ending in a wooden platform. These platforms are equipped with swings, tables, chairs, and other amenities to enhance the visitor experience. The platforms without furniture provide ideal spots for morning exercise as they are close to the accommodation facilities.
- An outdoor open-air nature education square, approximately 1,300 m^2, was built near the flag square in 2021 under the Multifunctional Forest Management Project Phase III to facilitate environmental education events. The floor area was paved with cement blocks, and the area was connected to water, electricity, and drainage facilities. Lighting, barbecue tables, chairs, and stoves were added to enable activities such as nature education events, campfires, and barbecues.

Figure 59: The wooden boardwalk under the forest canopy (Photo: Wangyedian Forest Farm)

- Under Phase III of the Multifunctional Forest Management Project, various tree species, shrubs, hedges, lawns, and flowering plants were incorporated into the Asia-Pacific Forest Town to improve the general aesthetics of the Forest Farm. Approximately 600 tree seedlings of common plum (*Prunus domestica*), euonymus (*Euonymus* spp.), and catalpa (*Catalpa ovata*) were planted in 2021. In the same year, approximately 1,670 m^2 of hedges composed of arborvitae (*Thuja occidentalis*), red-leaf plum (*Prunus cerasifera*), and lilac (*Syringa vulgaris*); 6,572 m^2 of flowering plants such as peony (*Paeonia lactiflora*), quince (*Cydonia oblonga*), and roses (*Rosa rubiginosa*); and 3573 m^2 of lawn were also planted (Figure 60).

APFNet's contribution to the development of tourism infrastructure has played a key role in transforming Wangyedian Forest Farm into a flagship ecotourism destination, aligning with Harqin Banner's "Fresh Landscapes, Healthy Ecotourism" policy framework. The Forest Farm features prominently in nearly all government-produced tourism promotion materials, raising public awareness and attracting widespread interest. In 2021, it was even featured on the CCTV-9 Documentary Channel. More recently, government-led promotional campaigns have spotlighted the site's ecological and recreational assets through cinematic documentaries and virtual tours, leveraging digital platforms like Douyin and WeChat to further boost its visibility. Nature-based activities such as forest hiking, mountain biking, and camping draw a large number of visitors annually, especially during the summer season when city dwellers seek to escape from the heat and relax in nature.

Figure 60: Landscaping structures (Photo: Wangyedian Forest Farm)

5.5.4 Accommodation at the Multifunctional Forest Management Demonstration and Experience Base

To enable Wangyedian Forest Farm to meet the evolving demands of sustainable tourism and to accommodate growing visitor demand, APFNet also supported the development of a variety of accommodation options. In addition to the rooms at the Multifunctional Forest Experiment and Training Center, purpose-built lodging facilities were developed—including a forest campsite, Asia-Pacific eco-lodges, and Mongolian ger houses—each designed to minimize ecological footprints while maximizing immersive nature experiences (Figure 61). In total, the Forest Farm can accommodate approximately 180 people. These facilities utilize closed-loop water systems, renewable energy, and zero-waste practices to align with the Global Sustainable Tourism Council Criteria. The buildings are designed to integrate traditional and culturally rooted construction methods with modern sustainable design principles.

Figure 61: Landscape view of the Multifunctional Forest Management Demonstration and Experience Base (Photo: Wangyedian Forest Farm)

Living in the Forest — Forest Campsite

In response to the growing popularity of camping, Wangyedian Forest Farm constructed a dedicated wilderness camping zone in 2021. It features eight wooden platforms set within an open-canopy forest stand (Figure 62), offering immersive forest experiences while remaining conveniently close to the forest experience base facilities. Each platform is elevated 60 cm above ground level, allowing for secure tent setup and natural drainage, mitigating flood risks associated with riparian ecosystems. The site is fitted with composting toilets and water stations. It is accessible via gravel paths and is lit with solar-powered lighting. Campers are encouraged to adhere to the 'Leave No Trace' principles.

Figure 62: Outdoor camping facilities (Photo: Ma Chenggong)

Experiencing Asia-Pacific — The Asia-Pacific Forest Town

The Asia-Pacific Forest Town was conceived as a living architectural exposition celebrating the cultural plurality of APFNet's member economies. This meticulously planned complex comprises 25 architecturally distinct ecolodges, symbolically representing the 24 member economies and APFNet itself. Each structure offers visitors a chance to experience a different architectural style —from Southeast Asian stilt-houses to Northeast Asian timber-frame techniques. The ecolodges are surrounded by curated planting schemes, featuring native trees, flowering understories, managed hedgerows, and drought-resistant grass varieties, adding to the experience of each lodge.

The lodges feature energy-recovery ventilation systems, solar thermal water heating, and high-speed Wi-Fi connectivity. Collectively, the 25 lodges can house 40 guests.

Australia

The Australia Lodge was built based on a typical Australian 'bungalow home'. The minimalist yet practical Queenslander design is historically influenced by colonial and US architecture.

(1 Tatami, 1 Double, 1 Living room, 2 Bathrooms)

Bangladesh

This Bengal-style bungalow also incorporates elements of Islamic Mughal architecture, especially evident in its roof structure. Unlike the traditional construction technique, which uses wood, bamboo, and khar (a local type of straw), the roof of this lodge is constructed solely out of wood.

(2 Double, 1 Living room, 2 Bathrooms)

Brunei

Built on stilts above the water, traditional houses in Brunei are made of wood and connected by wooden walkways. Inspired by this design, the Brunei Lodge features an extended veranda and a roof structure that resembles multiple dwellings.

(1 Tatami, 1 Double, 1 Living room, 2 Bathrooms)

Cambodia

This lodge reflects the traditional Khmer architectural style. It is built on stilts and features a steep, arched roof supported by a timber frame. Instead of traditional palm matting, the walls are constructed from wooden panels.

(1 Double, 1 Living room, 1 Bathroom)

Canada

Reflecting traditional, functional wood-framed country homesteads and taking inspiration from the French colonial style, the Canada Lodge is constructed of wood and has a steep roof with dormer windows.

(1 Tatami, 1 Double, 1 Living room, 2 Bathrooms)

China

The China Lodge reflects the traditional Chinese Siheyuan (四合院) architectural style, influenced by principles of feng shui. Departing from the conventional design, this lodge only has three sides. However, it retains symmetry and evokes a sense of an enclosed outdoor space.

(1 Reception room, 3 King Double rooms, 3 bathrooms)

Fiji

Traditional Fijian bure houses are typically windowless and feature palm or reed roofing. While the overall shape of the Fiji Lodge reflects this traditional style, it draws inspiration from modern design by incorporating windows for natural light and a wooden roof for added durability.

(1 Double, 1 Living room, 1 Bathroom)

India

The India Lodge is inspired by Indo-Saracenic and Indo-Islamic architecture, especially Mughal architecture. It features bulbous domes, arched windows, decorative ornaments, and lush greenery on all sides.

(1 Double, 1 Living room, 1 Bathroom)

Indonesia

Inspired by Rumah Gadang houses in West Sumatra, the Indonesia Lodge features a dramatic gonjong, a horn-like roof structure, and upswept gables. Similar to the traditional construction, the lodge is largely constructed of wood.

(1 Double, 1 Living room, 1 Bathroom)

Lao PDR

The Lao PDR Lodge takes its influence from traditional wat temples, with wooden construction and pitched roofs, blended with traditional stilted homes, French colonial style, and modern architecture.

(2 Double, 1 Living room, 2 Bathrooms)

Malaysia

Reflecting vernacular Malay architecture, the Malaysia Lodge is primarily wooden, built on stilts in the Ruman Panggung style, and has a typical gabled roof suited to tropical climates.

(1 Double, 1 Living room, 1 Bathroom)

Mexico

The brightly painted Mexico Lodge draws inspiration from traditional Mexican architecture, with its bold façade and scalloped central gable echoing Spanish Colonial design. Simple windows and painted trim reflect the vibrant, folk-influenced aesthetic of rural Mexican buildings.

(1 Tatami, 1 Double, 1 Living room, 2 Bathrooms)

Myanmar

The Myanmar Lodge features golden cladding, similar to that used on famous Buddhist pagodas and in traditional Burmese architecture. Its design blends traditional farmhouse elements with colonial influences, using wood as the primary material and raised on posts.

(1 Double, 1 Living room, 1 Bathroom)

Mongolia

This wooden structure reflects a modern take on traditional Mongolian ger design, featuring a circular layout, domed roof with a central finial, and natural wood exterior. It blends vernacular form with modern materials for comfort and cultural continuity.

(1 Double, 1 Living room, 1 Bathroom)

Nepal

Merging art and practicality, the Nepal Lodge draws inspiration from Nepali architecture. Its pagoda style, originally derived from the shape of Himalayan fir trees and common in Nepal's Hindu temples, is blended with the traditional Newa design, featuring narrow windows.

(1 Double, 1 Living room, 1 Bathroom)

New Zealand

This lodge reflects New Zealand's cottage-style architecture, characterized by steep gable roofs, symmetrical facades, and light-colored timber cladding. The triangular windows add a touch of modern charm, while the compact form and simple lines emphasize functionality, comfort, and harmony with the natural surroundings.

(2 Double, 1 Living room, 2 Bathrooms)

Papua New Guinea

The Papua New Guinea Lodge takes inspiration from churches established during the introduction of Christianity in the late 19th century, blending these elements with traditional architectural features such as deep gables and sweeping, pitched roofs.

(1 Twin, 1 Double, 1 Living room, 2 Bathrooms)

Peru

This lodge reflects a vibrant Peruvian-inspired architectural style, characterized by bold colors, symmetrical layout, and decorative domes and finials. The flat roof with ornamental battlements echoes colonial and Andean influences, while the bright yellow facade reflects the cheerful and lively aesthetics often found in traditional Peruvian towns.

(1 Tatami, 1 Double, 1 Living room, 2 Bathrooms)

The Philippines

The lodge's architecture incorporates many Spanish elements, as the arrival of the Spaniards in 1571 introduced European colonial architecture.

(1 Twin, 1 Double, 1 Living room, 2 Bathrooms)

Singapore

The Singapore Lodge's architecture is inspired by the iconic shop houses, colonial influences, and traditional Kampong style, featuring buildings raised above the ground. Painted in vibrant pink and green with a red roof, the lodge reflects the bright and lively color palettes often seen in Singapore's historic shop houses and neighborhoods.

(2 Double, 1 Living room, 2 Bathrooms)

Sri Lanka

Influenced by Sri Lanka's Buddhist stupas, the Sri Lanka Lodge features a distinctive round shape. Its roof design draws inspiration from colonial-era buildings, showcasing a vibrant red roof that contrasts strikingly with the grey walls.

(1 Double, 1 Living room, 1 Bathroom)

Thailand

The Thailand Lodge imitates traditional Thai architecture, built with wood on head-height stilts and featuring high gable roofs with long, overhanging eaves. The undulating serpentine lamyong roof finials, typically found on religious buildings, evoke the fins of the Nāga (a divine mythical half-human, half-serpent being) and the feathers of Garuda (a Hindu bird-like deity also revered in Buddhism).

(1 Double, 1 Living room, 1 Bathroom)

The US

This lodge reflects a classic American cottage style, featuring a simple gable roof, modest front porch, and symmetrical window placement. The dormer adds charm and functionality, often seen in suburban or rural homes across the United States. The clean lines and muted gray siding emphasize practicality and understated elegance.

(1 Tatami, 1 Double, 1 Living room, 2 Bathrooms)

Viet Nam

The Viet Nam Lodge's architecture is inspired by traditional Vietnamese homes, featuring stilted wooden structures, an odd number of rooms, and gabled roofs. It is painted an earthy red to reflect the natural materials typically found in Vietnamese construction.

(1 Double, 1 Living room, 1 Bathroom)

APFNet

Completing the Asia-Pacific Forest Town is the APFNet Lodge. Built in a modern architectural style with wood construction, its large windows maximize natural light throughout the rooms. The spacious 2nd-floor terrace offers an ideal space for group gatherings.

(1 Twin, 1 Double, 1 Living room, 3 Bathrooms, 1 Terrace)

Embracing Local Culture — Mongolian Ger Houses

Figure 63: Mongolian folk houses (Photo: Wangyedian Forest Farm)

To support engagement with Inner Mongolia's nomadic heritage, 20 Mongolian ger-inspired dwellings were constructed in the Base (Figure 63). The houses come in different sizes, including family suites with king-size beds; group lodges with bunk beds; and minimalist lodges with tatami mat flooring. Built with locally sourced timber and rammed earth techniques, they are all installed with passive ventilation and HVAC systems, hot-water supply, and WiFi. The Mongolian ger houses have been particularly favored by students and families during school holidays for nature education activities.

The Service Center

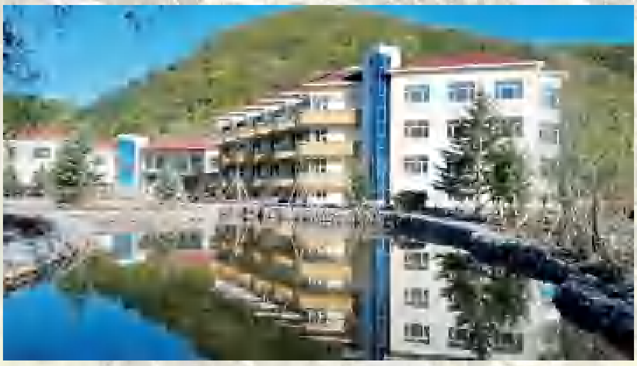


Figure 64: The Service Center at Wangyedian Forest Farm (Photo: Wangyedian Forest Farm)

The Service Center serves as the main reception of the Base, offering accommodation and conference facilities across a total floor area of over 5,000 m^2 (Figure 64). It is well-equipped with a self-service restaurant, eight private dining rooms, a lounge, and two conference rooms that can accommodate 100 and 30 participants respectively. The facility also includes 38 guest rooms with a total capacity of up to 70 guests. Outdoor amenities include a music and barbecue plaza, a large Mongolian yurt (20 m in diameter) capable of hosting meetings of up to 150 people, and a 4,800 m^2 parking area.

6

Training and Capacity Building

6.1 Training

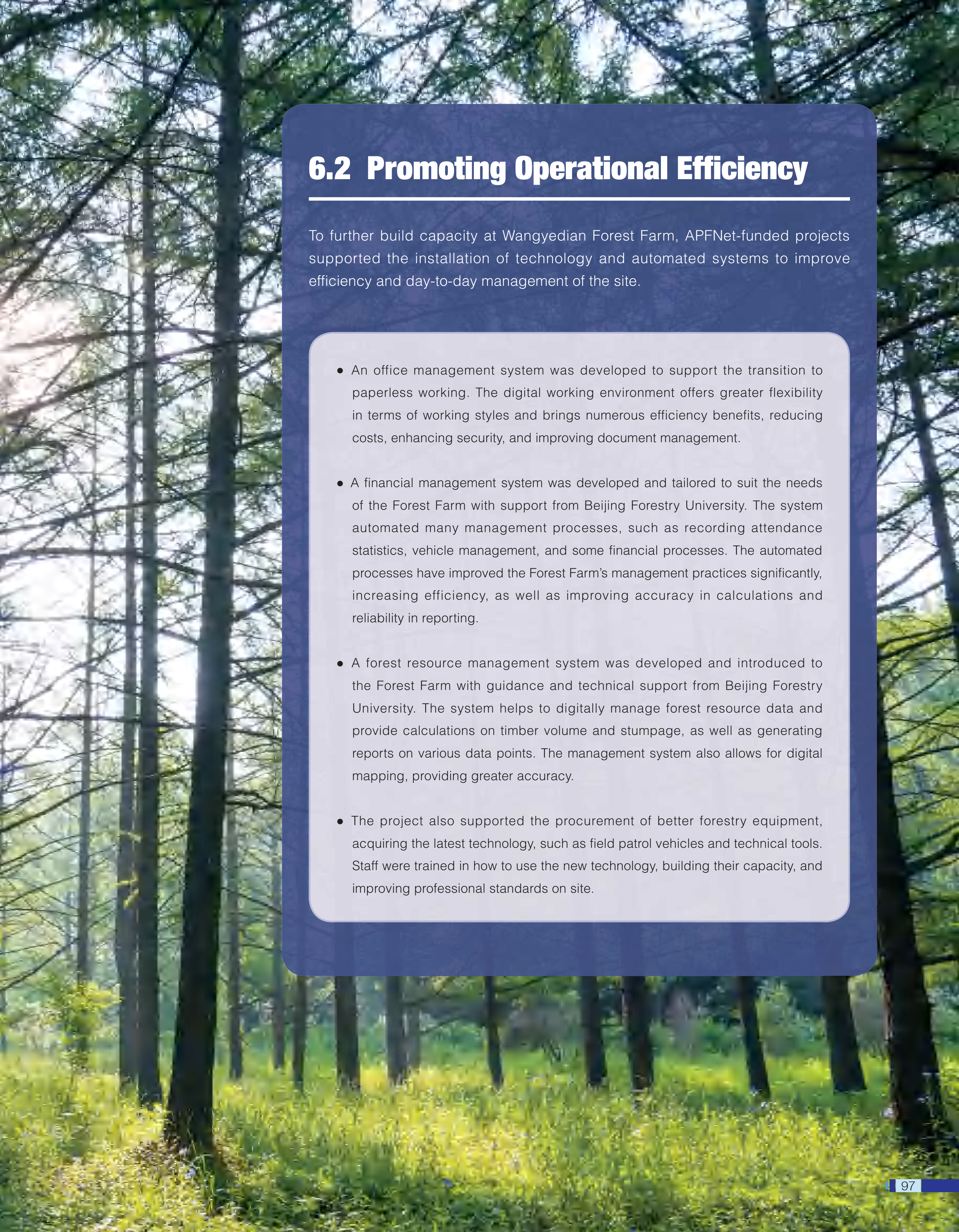
To ensure the sustainability of the initiatives at Wangyedian Forest Farm and to support socio-economic development, capacity building was embedded in the objectives of the APFNet-funded project series. Training programs were delivered to provide Forest Farm officials and the local community with the tools to independently carry out and promote sustainable forest management and maximize sustainable tourism opportunities. The following are some examples of on-site training delivered through the projects:

- Multiple training sessions on CNFM were held for Forest Farm technicians. The programs focused on tree selection, harvesting of competitor trees, accurate measurement of standing trees using electronic theodolites, sample plot surveys, and advanced nursery practices.

- Theoretical and technical training on multifunctional forest management, with special emphasis on CNFM and tourism, was held at the Forest Farm in October 2018. Experts from the Chinese Academy of Forestry and Beijing Forestry University were invited to conduct this workshop, and approximately 50 people from the Forest Farm and the local community joined. The workshop helped participants gain a clearer understanding of the objectives behind a forest experience base, as well as their roles and responsibilities in managing it. It also highlighted how to maximize the potential for nature-based tourism while respecting ecological carrying capacities.

- In 2018, experts from Beijing Forestry University were invited to hold a training workshop targeting tourism service personnel specifically. About 50 local community members and staff from the Forest Farm participated. Training content included tourist reception, food and beverage management, and tour guiding. Through this training, community people and service personnel have deepened their understanding of forest tourism, and standardized and improved service delivery.

In addition to the on-site training, the Forest Farm's senior management staff were provided with opportunities to attend training programs and workshops in other regions of China and abroad. For example, they took part in a one-week study tour in Canada in December 2022. The workshops and study tours provided an opportunity to observe sustainable forestry management practices in different settings, understanding different management concepts and business models that could enrich the existing management practices at Wangyedian Forest Farm.



6.2 Promoting Operational Efficiency

To further build capacity at Wangyedian Forest Farm, APFNet-funded projects supported the installation of technology and automated systems to improve efficiency and day-to-day management of the site.

- An office management system was developed to support the transition to paperless working. The digital working environment offers greater flexibility in terms of working styles and brings numerous efficiency benefits, reducing costs, enhancing security, and improving document management.

- A financial management system was developed and tailored to suit the needs of the Forest Farm with support from Beijing Forestry University. The system automated many management processes, such as recording attendance statistics, vehicle management, and some financial processes. The automated processes have improved the Forest Farm's management practices significantly, increasing efficiency, as well as improving accuracy in calculations and reliability in reporting.

- A forest resource management system was developed and introduced to the Forest Farm with guidance and technical support from Beijing Forestry University. The system helps to digitally manage forest resource data and provide calculations on timber volume and stumpage, as well as generating reports on various data points. The management system also allows for digital mapping, providing greater accuracy.

- The project also supported the procurement of better forestry equipment, acquiring the latest technology, such as field patrol vehicles and technical tools. Staff were trained in how to use the new technology, building their capacity, and improving professional standards on site.

7

A Decade of APFNet and Wangyedian Forest Farm

7.1 Key Achievements and Developments

Sustained funding and support from APFNet over a ten-year period has enabled Wangyedian Forest Farm to implement a wide range of initiatives and demonstration models showcasing the potential for sustainable forest management, multifunctional forestry, and sustainable development.

- **Empowering Learning in Sustainable Forestry and Nature-Based Education**

To date, the Multifunctional Forest Management Demonstration and Experience Base has welcomed thousands of visitors, including government and forestry representatives from both China and abroad, academic researchers, school groups, and tourists. By integrating education and recreation, the Base inspires a deeper understanding and appreciation of forest ecosystems and the principles of sustainability. In addition to demonstrating sustainable forestry practices to visitors, the Base also serves as a hub that facilitates dialogue and knowledge exchange, further advancing the development of sustainable forestry across the region and beyond.

- **Advancing Multifunctional Forest Management and Close-to-Nature Forest Management**

The demonstration models and scientific research carried out at Wangyedian Forest Farm have contributed to the development of multifunctional forest management in continental monsoon climates. The site now serves as a replicable and scalable demonstration model of multifunctional forest management and close-to-nature forest management. The project outputs, including academic articles, technical guidelines, and brochures, all further contribute to the advancement of sustainable forest management, especially close-to-nature forest management, sharing the lessons learned with a wider audience.

- **Championing Sustainable Community Development, Livelihood Diversification, and Capacity Building**

Supporting sustainable socio-economic development has been central to the projects at Wangyedian Forest Farm. The projects successfully implemented multiple livelihood diversification models that have seen an increase in income for local communities and created a diverse range of employment opportunities. Alongside the models, such as nature-based tourism, mushroom cultivation, seedling production, and silvopasture, communities were given the opportunity to join training programs and workshops on topics such as sustainable utilization of non-timber forest products and eco-tourism to further build capacity for sustainable development. Alongside livelihood diversification, community empowerment was enhanced through the community co-management program, which gave local residents decision-making power and a say in forest and resource management.

- **Long-term Sustainability and Resilience of the Forest Farm**

In addition to shorter-term plans, the fifteen-year Multifunctional Forest Management Plan provides greater flexibility, stability, and effectiveness in achieving forest management objectives. Supporting this, the modernization of forest management infrastructure, e.g. nurseries, and management techniques, including the digitalization of forest management tools and the installation of video monitoring systems to prevent forest fires, has strengthened the Forest Farm's capacity, contributing to long-term sustainability and resilience. In addition, the transition to multifunctional forest management and close-to-nature forest management has created greater environmental resilience, securing the future of the Forest Farm.

7.2 Lessons Learned

The Multifunctional Forest Management Project supported the introduction of advanced forest management techniques at Wangyedian Forest Farm over a period of more than ten years, offering a wealth of learning opportunities. Key lessons from the project are summarised below:

Forestry projects require significant investment in infrastructure, technology, and human resources, and they often take longer to generate returns compared to other sectors. A long-term commitment is essential to ensure that these investments are economically viable and lead to sustained results, whether in terms of ecological restoration, economic returns, or social impact. APFNet's continued financial support and engagement over more than ten years have been a key factor in the success of this project.

Forestry planning is essential for long-term sustainable forest management as it enables strategic resource allocation, risk management, goal setting, stakeholder engagement, adaptive management approaches, and legal compliance. The ten-year multifunctional forest management plan, which was developed through systematic resource analysis, will serve as a critical tool to guide the Forest Farm in managing its forests more efficiently, effectively, and sustainably.

Private sector investment can be an enabler of sustainable forest management. Capital is often the missing link in translating sustainability initiatives into practice, and private investment not only helps fill that gap but can also drive innovation, support technology adoption, expand market access, and improve value chains. In this project, utilizing the knowledge and resources of the private sector in mushroom production and nursery development contributed to innovative community-based models that enhanced local livelihoods, while also delivering benefits to the private partners.

In contrast to traditional monoculture plantation systems focused solely on timber production, CNFM enhances biodiversity, strengthens ecosystem services such as soil and water conservation, and supports cultural and aesthetic values, whilst maintaining sustainable timber yields. The introduction of CNFM at Wangyedian Forest Farm has contributed to the long-term sustainability and ecological resilience of the forest and improved the well-being of surrounding communities.

Community co-management empowers local communities by giving them a meaningful voice in decisions that affect their lives and livelihoods. This approach fosters a sense of ownership, responsibility, and accountability, leading to increased motivation and commitment to sustainable forest management practices. By encouraging collaboration and partnership between the Forest Farm and community members, the project has introduced more inclusive and sustainable forest management approaches that benefit both the local population as well as the Forest Farm itself.

Capacity building is essential for the long-term success of sustainable and multifunctional forest management projects because it develops the critical knowledge, skills, systems, and collaboration needed to empower stakeholders to manage forests responsibly while supporting their livelihoods. The ongoing investment in capacity building through this project has significantly strengthened stakeholders' foundation and confidence, enabling them to successfully implement project objectives and champion sustainable forest management at Wangyedian Forest Farm.

Nature-based tourism has the potential to play a vital role in promoting multifunctional forest management, enhancing community livelihoods, and strengthening community engagement by creating diverse economic opportunities and incentivizing conservation. Improved tourism infrastructure developed through this project at Wangyedian Forest Farm has not only enriched the visitor experience, combining recreation with education, but also contributed to the overall development of the area.

Forests offer a wide range of goods and services beyond timber that can be sustainably used to support local income generation. By involving local communities in livelihood initiatives and planning for the sustainable use of NTFPs, this project has not only significantly improved local livelihoods but also generated case studies and good practice models that inform broader applications and scaling up of similar initiatives.

Forests produce a variety of often overlooked residual materials that can be innovatively repurposed as raw inputs for other industries, generating multiple benefits. This project launched a collaborative mushroom cultivation initiative that utilized logging residues and fallen branches from the Forest Farm as mushroom cultivation media. This initiative delivered mutual benefits to both the local community and the private sector partner, while also helping to reduce fire risk within the Forest Farm.

Forests often have abundant understory space that can be sustainably utilized, for example, by growing high-value crops or practicing low-impact animal husbandry. The project introduced understory mushroom cultivation and silvopasture models, providing excellent examples for wider replication and scaling up in many suitable forest ecosystems.

7.3 Looking Ahead

- The project supported capacity-building programs for employees of the Forest Farm and nearby communities. To ensure staff and local stakeholders keep up-to-date with emerging technologies, innovations, research, and evolving practices in multifunctional forest management, continuous professional development should be embedded into the Forest Farm's management strategy.
- The infrastructure developed through the project has established the Forest Farm as a leading hub for nature-based education, scientific research, forestry training, and ecotourism. There is potential to further increase domestic and international engagement with these facilities through targeted outreach campaigns.
- Permanent sample plots established through the project enable long-term evaluation of forest management interventions. Maintaining these monitoring sites, along with consistent data collection and recording, is critical for generating scientific insights that inform effective forest management strategies.
- Livelihood development strategies piloted during the project have expanded local employment and income opportunities. Ensuring post-project sustainability will require continued monitoring to evaluate effectiveness and replicability, supported by further research and case study development to facilitate broader dissemination.
- The experience of developing and applying multifunctional forestry in Wangyedian illustrates that forests are more than stands of trees—they are living systems that sustain biodiversity, regulate climate, provide livelihoods, and enrich culture. By integrating ecological restoration, sustainable management, and community participation, this approach demonstrates a pathway towards forests that are productive, resilient, and harmonious with human needs. As pressures from climate change and social transformation continue to grow, the lessons drawn from this work offer guidance well beyond Inner Mongolia: that the future of forestry lies in balance, diversity, and stewardship.

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