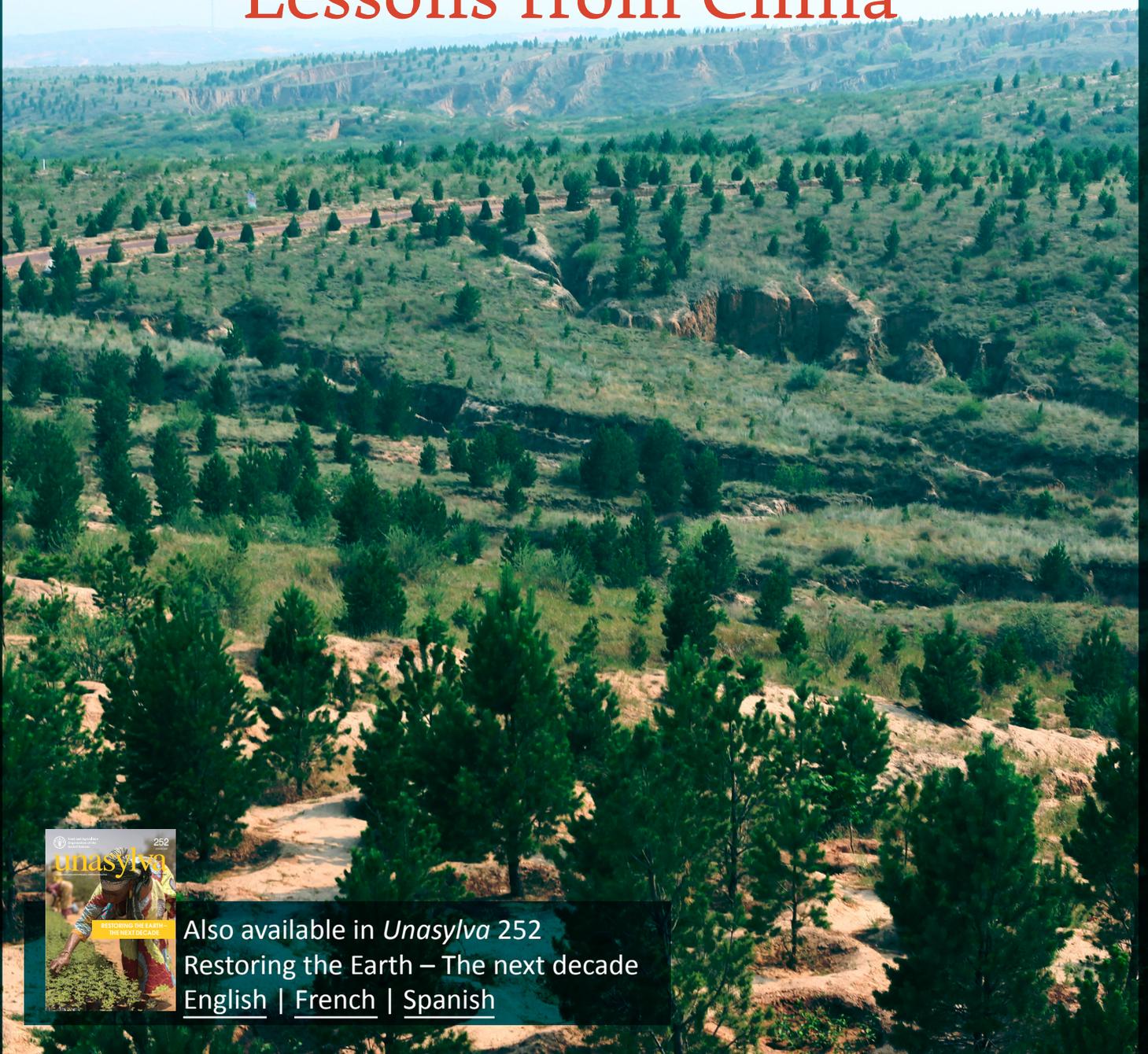


Taking forest and landscape restoration to **scale**

Lessons from China



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Taking forest and landscape restoration to scale: lessons from China

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The country's success in reversing centuries of forest degradation and loss shows that large-scale restoration is possible given political leadership, multistakeholder involvement and an adaptive management approach.

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Large-scale forest and landscape restoration has emerged as an important global priority. Both the Bonn Challenge and the New York Declaration on Forests call for the restoration of 350 million hectares (ha) of degraded forest land globally by 2030. More recently, FAO has proposed the restoration of 900 million ha of degraded rural lands as a key measure to address land degradation and combat climate change. In March 2019, the United Nations General Assembly declared 2021–2030 as the United Nations Decade on Ecosystem Restoration.

Although the ambition for forest restoration is high, implementation has been slow, with only 26.7 million ha of new forests established since 2000 (NYDF Assessment Partners, 2019). In addition, scientists have warned that forest restoration must be viewed as an additional

measure rather than a substitute for action to cut emissions, and also that restoration efforts need to be targeted carefully to produce desired effects (Betts, 2011; Arora and Montenegro, 2011). Scientists have also noted the potential for adverse environmental outcomes when forest planting is extended to areas with low capability to support sustainable tree establishment or to non-forest areas with significant environmental values such as natural grasslands and wetlands (Cao, 2008; Farley and Jackson, 2005; Jiang, 2016).

China is one of only a few countries to have reversed centuries of forest loss and degradation in recent decades and to

Above: China's massive restoration effort has included tree-planting in extraordinary terrain on the Loess Plateau to reduce sedimentation in the Yellow River

have dramatically increased its forest area: forest cover in the country has increased from 8.6 percent of the national land area at the time of the formation of the People's Republic of China in 1949 to 23 percent today (Figure 1). Much of this expansion has been driven by large-scale “ecoforestry” projects designed to restore or enhance ecosystem services, ranging from erosion control and watershed protection to cropland protection, desertification control, landscape amenity and carbon sequestration. This article explores the achievements of China's ecoforestry programmes, which started in 1978, and the challenges they have faced, and it discusses the key lessons learned that may help others in achieving large-scale forest restoration.

CHINA'S HISTORY OF FOREST LOSS AND DEGRADATION

Many of today's global challenges related to environmental degradation, forests and forestry have long been concerns in China. Throughout China's vast history, its forests have suffered as societies have prospered. Elvin (2001) characterized Chinese history as 3 000 years of unsustainable growth; Lamb (2010) described China as an archetypal example of a society that had

been unable to prevent almost complete deforestation.

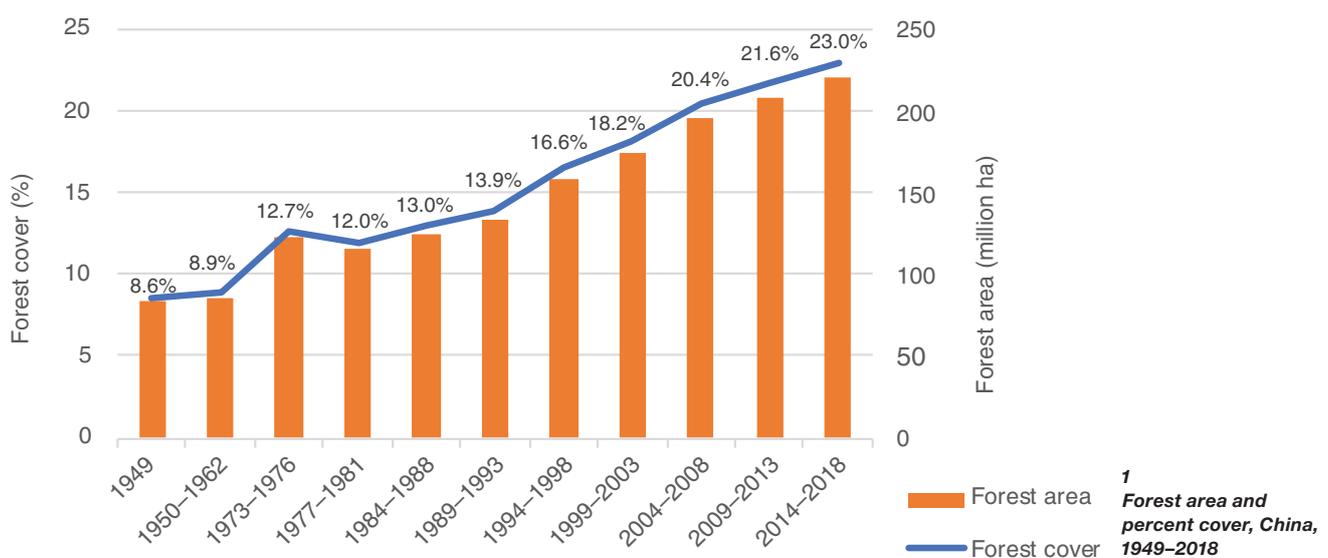
Lamb (2010) also noted that deforestation occurred in China despite a philosophical tradition involving a reverential attitude to nature, rich silvicultural knowledge, an understanding of the functional and protective roles of forests, and a strong political apparatus that had built a unified state. Forest degradation and loss continued for reasons common to many developing countries today: the limited ability of successive governments to use existing knowledge to implement their policies, and the fact that enlightened philosophical views about nature were confined to a small proportion of the population. Most people lived in rural areas and used nature and its resources in a continuous struggle to feed themselves and survive. With an increasing population, peasant farmers needed new lands, fuel, and building materials, and forests were the natural source of these. Over several thousand years, farmers continued to expand into and clear new forest lands until, eventually, the limits were reached. The loss and degradation of forests, wetlands, grasslands and shrublands through landclearing, overgrazing and other agents led to the degradation

and loss of ecosystem services and consequently to serious problems with erosion, stream sedimentation, flooding, declining agricultural productivity, desertification, sand storms and biodiversity loss.

EARLY EXPERIENCES WITH FOREST RESTORATION

Although the overall trajectory of net forest degradation and loss continued into the modern era, China also has a long history of people responding to local problems by instigating forest restoration and protection measures. Afforestation in arid and semiarid China can be traced back at least 2 300 years (Wang *et al.*, 2010). Miller (2020) charted the rise of timber plantations in China between about 1 000 and 1 700 CE, when natural forests were increasingly replaced by planted forests.

When the People's Republic of China was created in 1949, it inherited both a legacy of forest degradation and loss and historical experience with reforestation. Forest cover was low, with many provinces virtually treeless. The perilous state of the country's forests seems to have been well recognized by the incoming political leadership, with the First Plenary of the Chinese People's Political Consultative Conference



Sources: National Forestry and Grassland Administration (2016, undated); Song and Zhang (2009).

in September 1949 adopting a common programme that contained provisions to protect forests and develop forestry in a planned way (Richardson, 1966; Zhou, 2006).

Similarly to previous administrations, however, China's new leadership was constrained economically and unable to implement its well-intentioned policies or to turn an understanding of the functional and protective roles of forests into practice. Forests were mobilized to meet the immediate needs of economic development and reconstruction following the long years of war.

Early afforestation efforts were also hampered by inappropriate incentives, underdeveloped silvicultural techniques and low rates of survival. Nevertheless, by the 1970s, China had amassed considerable experience and success in both afforestation and the use of forest management to support agriculture. Although, overall, forest policy still favoured the unsustainable exploitation of natural forests and some conversion of forests to farmland,

afforestation programmes were encouraged along roads, rivers and canals and around houses and villages. By the late 1970s, institutional arrangements were well established that linked political decision-makers, technicians and forest and farm workers. By world standards, the country had already achieved large-scale afforestation, with overall forest cover reaching 10 percent of the total land area (FAO, 1978) (up from 8.6 percent in 1949).

CHINA'S LARGE-SCALE ECOFORESTRY PROGRAMMES

China launched the first of its large-scale ecoforestry programmes in November 1978 following huge dust storms and in light of growing recognition of the costs of environmental degradation. The first programme – the Three-North Shelterbelt Development Programme (hereafter the Three-North Programme) – was vast in both scale and duration (Zhou, 2006; Box 1). The programme made early progress; by its fortieth anniversary in 2018 it had facilitated the planting of 46.1

million ha in challenging environments. Overcoming initial challenges, including low rates of survival, the programme achieved a net expansion of forest cover of 30.1 million ha (CAS, 2018). Carbon sequestration from these forests has been estimated at 5 percent of China's total industrial emissions over the same period.

With the early success of the Three-North Programme, a national tree-planting programme and other shelterbelt development programmes were initiated in the 1980s (Box 2). A series of catastrophic events, including flood disasters in the Yangtze and Sonhuajiang river basins in 1998 and unprecedented dust storms in Beijing and other areas in 2000, prompted a dramatic expansion of China's ecoforestry and associated land sustainability programmes (Bryan *et al.*, 2018; Zhou, 2006). Overall, the investment in 16 major sustainability programmes between 1978 and 2015 totalled USD 378.5 billion (in 2015 dollars), with annual programme support growing steadily (as China's economy grew) to more than USD 40 billion per year



Integrated forest and agricultural land use in a restored catchment in Baijun County, Heilongjiang Province

Box 1 The Three-North Shelterbelt Development Programme

The Three-North Programme was established by the Central Committee of the Chinese Communist Party and the State Council of China in November 1978 to improve natural and economic conditions in the country's north, northeast and northwest (hence "Three-North") regions for sustainable development. The programme covered about 4 million km², from Bin County in Heilongjiang Province in the east to the Wuzhibile Mountains in Xinjiang in the west – some 42 percent of China's land area; it was 4 480 km in length and 560–1 440 km wide and extended over 551 counties in 13 provinces. The planning horizon was 73 years, and the programme was implemented in eight phases. Its achievements, which had three components (farmland shelterbelt, erosion control, and combating desertification), have matched the scale of its ambition.

Farmland and infrastructure shelterbelts

More than 2.8 million ha of farmland shelterbelts had been established under the programme by 2015. This green infrastructure offered protection to 30 million ha of existing farmland and led to the reclamation of an additional 15 million ha of farmland and pasture. It has been estimated that this has accounted for as much as 20 percent of the increase in the national grain harvest over the last 40 years.



Farmland shelterbelts have increased agricultural yields substantially

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Erosion control on the Loess Plateau

Under this project, which ran from 1994 to 2002, about 9.6 million ha of watershed protection forests were established on the Loess Plateau (see photo on page 9); sediment levels in the Yellow River fell by up to 90 percent; and livelihoods were improved by the incorporation of economic crops such as walnuts and apples in restoration plantings.

By 2015, for example, over 6.6 million ha of fruit plantations had been established, producing 48 million tonnes of dry and fresh fruits annually with an output value of CNY 120 billion (USD 17 billion). According to Chen, Wang and Wang (2004), the proportion of people in the area living in poverty dropped from 59 percent in 1993 to 27 percent in 2001.

Sand ecosystem management to combat desertification

Under this project, 3.4 million ha of sand ecosystems have been brought under management and converted to fertile farmland, and China's sand ecosystem is now reducing by 150 000 ha per year. Sand stabilization has enabled the protection of villages and key infrastructure such as roads and railway lines.



Villagers plant grasses in 2018 as part of efforts to combat desertification

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Box 2 China's other key ecoforestry projects

National Tree-planting Campaign. The National People's Congress launched this programme in 1981 to facilitate wide participation in tree-planting. It was designed to raise public awareness of afforestation, accelerate the reforestation of barren hillsides, improve ecological conditions in rural and urban areas, and promote ground-level greening in all sectors.

The shelterbelt development programmes in the Yangtze River basin and other regions. These programmes, which began in 1987, extended shelterbelt development to five additional regions covering the Yangtze and Pearl rivers and their coastal areas and plains, and the Taihang Mountains.

Natural Forest Conservation Programme. This programme, initiated in 1998, sought to halt logging and deforestation to protect natural forests for ecological and carbon benefits. It created new business opportunities for traditional forest enterprises as well as jobs in forest management, and it assisted redundant forestry workers with relocation.

Grain-for-Green Programme. This programme started in 1999 to prevent soil erosion, mitigate flooding, store carbon and improve livelihoods by increasing forest and grassland cover on steep hills and by converting croplands, barren hills and wastelands to forests. The programme provided grain and cash as incentives and compensation for not cultivating some types of land and, rather, converting it to forests, woodlands or grasslands.

Fast-Growing and High-Yielding Timber Programme. This programme, which was implemented between 2001 and 2015, was designed to remedy the decline in timber supply due to the withdrawal of natural forests from production. It focused on regions with potential for plantation development.

Sandstorm Source Control Programme around the Beijing-Tianjin Region. The aim of this programme, initiated in 2001, was to reduce desertification and dust storms and improve the environment in the Beijing-Tianjin area through reforestation, grassland management and watershed management.

Wetland Conservation Programme. This programme supported projects designed to enhance the conservation and restoration of important natural wetlands. The integration of the programme with other key programmes, such as the Natural Forest Protection Programme and the various shelterbelt programmes, helped significantly reduce sedimentation in key wetland areas.

Rocky Desertification Control Programme. This programme, which began in 2008, was designed to curb land degradation in karst areas in China by improving environmental conditions and increasing local incomes in those areas. The programme focused on protecting and establishing vegetation, encouraging sustainable land use and water conservation, and supporting the relocation of poor people from degraded areas.

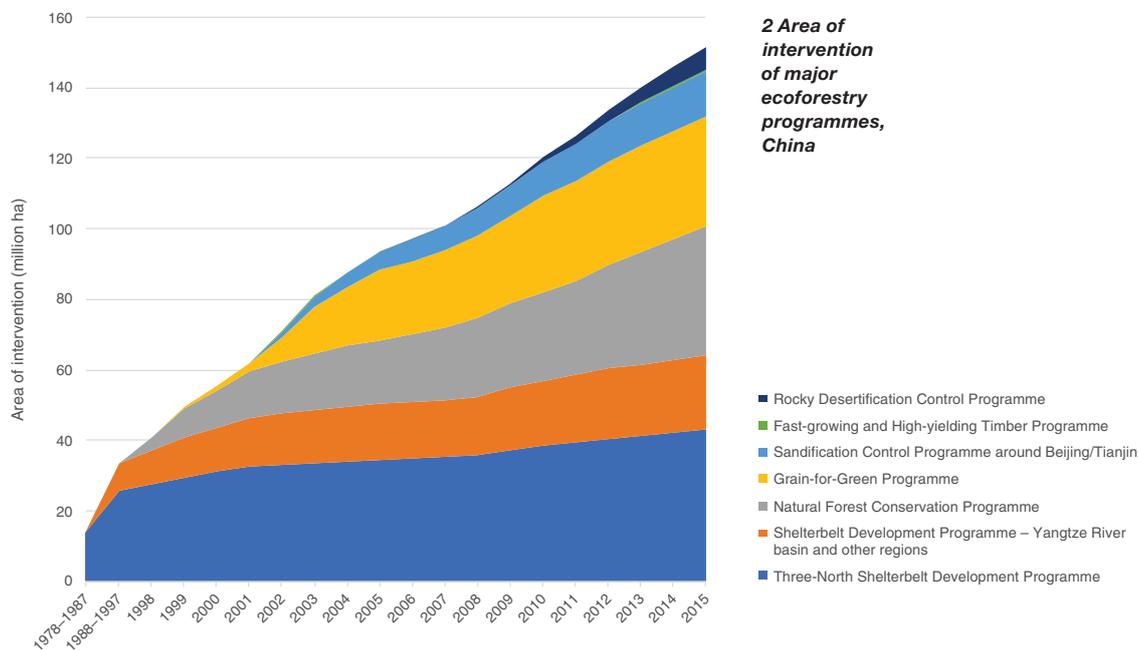
Sources: APFNet (2012); Bryan *et al.* (2018).

in 2015 (which was 0.37 percent of gross domestic product) (Bryan *et al.*, 2018).

Together, these programmes, combined with other sustainability programmes to address, for example, soil and water conservation, wildlife conservation, grassland protection and the quality of cultivated land, have led to the substantial recovery of land cover and ecological function (Bryan *et al.*, 2018). In total, the programmes (including non-forestry programmes) have covered more than

600 million ha or 62 percent of China's land area (see Figure 2 for the coverage of the main forest-oriented programmes). This has dramatically expanded forest and other vegetative cover, reduced sediment loads in major rivers, enhanced habitat restoration and biodiversity and assisted in obtaining increases in crop production and food security. Given that most of the heavily degraded lands also had higher incidences of poverty and slower economic growth, China's forest restoration and land

sustainability programmes have generally increased incomes and reduced poverty in programme areas, although the local economic effects have varied greatly (Liu, Yin and Zhao, 2018). To date, no assessment has been made of the national-level economic impacts of the programmes, which were established primarily for environmental and local and regional poverty-alleviation purposes.



Source: Bryan *et al.* (2018).



The degraded landscape of Sanguyao village, Tiebian township, Wuqi County, Shaanxi Province, on 24 September 1984



The same landscape 28 years later, on 24 September 2012, after restoration

DRIVERS OF SUCCESS

China's success with large-scale ecoforestry, land restoration and resource sustainability is due to many factors. The most important are described below.

Sustained political and budgetary support

All of China's large-scale ecoforestry and land sustainability programmes have operated under multidecadal timeframes and with sustained high-level political and budgetary support. Once the implications of continued forest degradation and loss (and

associated land and resource sustainability problems) were fully recognized, national-level programmes were initiated with full policy and legislative support. Sustainable forest conservation, management and restoration, and ensuring resource sustainability, became high-level public-policy concerns similar to health, defence and education, and they were backed with ongoing policy and budgetary support.

Mass mobilization and participation

In the early days of the programmes, the bulk of China's population still lived

in rural areas on farms and communes. Planning and management followed norms for the agriculture sector as a whole; and local demonstrations of best practice served as models to enable surrounding farms and farmers to improve management through a process of learning by doing. Planning at the local level was made by "three-in-one formations" comprising technicians, commune members and party cadres. These formations considered the following three criteria for the selection of crops and activities: 1) site conditions and the suitability of the land for agriculture, forestry or animal production; 2) national targets; and 3) local people's needs. Before a plan was adopted and implemented, it was reviewed and refined through a participatory process linking provincial and district planning teams with forest production brigades at the commune or village level.

Broadscale communication and extension efforts convinced a large portion of the national population to support tree-planting because it would, over time, contribute to collective and individual well-being (FAO, 1978). This high level of "tree consciousness" was further developed by later programmes such as the National

Tree-planting Campaign. Incentives were paid to those people and bodies implementing activities – usually farmers and forest-farm units. It was recognized, however, that these incentives would need to increase with the gradual development of the market system and higher levels of labour mobility (Zhou, 2006). For example, tree-planting payments under the Three-North Programme were initially CNY 150 (USD 60 at the time) per hectare. Payments had risen to CNY 7 500 (USD 1 071) per hectare by 2017 (Zhu and Zheng, 2019).

Later programmes such as the Natural Forest Protection Programme and the Grain-for-Green Programme involved retiring land use and the voluntary or involuntary resettlement of farmers away from vulnerable and degraded sites. These programmes had a socio-economic focus on reducing poverty as well as enabling environmental outcomes, which overcame these challenges. A wide range of incentives was paid to affected farmers, and considerable efforts were made to diversify their off-farm incomes through the establishment of orchards and village enterprises such as fish ponds and pig raising (Cao *et al.*, 2017). The efforts were greatly assisted by China's rapid economic development; nevertheless, it is recognized that, in some areas, there is a need for ongoing payments for the provision of ecosystem services to secure long-term sustainability (Bryan *et al.*, 2018).

Coordinated governance and management

The central government led programme governance and also provided most of the funding. It was supported by partnerships with, and co-investment from, provincial and local governments as well as enterprises and individuals (Bryan *et al.*, 2018). With the help of research agencies, the central government designed the programmes, set high-level objectives and delegated responsibilities to relevant agencies such as the National Forestry and Grassland Administration (and its predecessors). These agencies planned

the detailed scope and priorities of programmes and coordinated implementation, allocating tasks to provincial government departments. Provincial and local government departments refined and adapted the programmes based on local needs, conditions and priorities and developed and implemented projects and managed funding. Monitoring and quality assurance involved self-appraisal, inspection at the local, provincial and national levels, and verification against accepted performance standards. Underperformance resulted in penalties, including withheld payments.

Development partnerships and learning by doing

China's implementation of its major ecoforestry and land sustainability programmes was supported by bilateral and multilateral assistance programmes offered by the World Bank, FAO and the Sino-German Forestry Programme. This helped accelerate capacity building in forest science and restoration management and, as the programmes developed, to facilitate the documentation and dissemination of lessons learned. Adaptive management based on learning by doing has been a feature of the programmes, with pilots, trials and staged rollouts employed to enhance learning and project success.

A focus on livelihoods as well as ecosystem services

Although most forest plantings and restoration efforts focused on environmental objectives, economic tree crops such as fruit and nut trees were used widely to increase the incomes of participating villages and communes. Pilot sites demonstrating that the establishment of shelterbelts increased crop production inspired their replication across large areas of farmland. Where a programme involved retiring marginal lands from production, compensation payments were made for up to eight years, with an extension of an additional eight years to further reduce poverty and generate alternative employment and income (Liu, Yin and Zhao, 2018).

CHALLENGES

Although the programmes have been impressive in both scale and impact, their implementation has not been without significant challenges, and additional issues are emerging that ultimately will need to be addressed. Some of these are described below.

Low survival rates and inappropriate species selection

In the early days, many of the areas targeted for restoration were barren, with long histories of land degradation. Many sites, particularly in the Three-North Region, were harsh, windy and cold, with short growing seasons; this presented a significant challenge for restoration. The limited availability of planting materials often led to an overreliance on single species and consequent problems with pests and disease. As noted earlier, the Three-North Programme increased forest cover by 30.1 million ha over 40 years, but the equivalent of 46.1 million ha was planted, an effective success rate of just 65 percent.

Tree-seedling survival rates were very low in many areas. Farmers informally told two of the authors in 2019 that today's trees have been "built on the shoulders" of previous dead trees; some cynically described plantings as "green in year 1, yellow in year 2 and brown in year 3". In drier areas, there were instances where reforestation was overused as the prime restoration tool, even in environments that may not have previously supported forest vegetation (Cao, 2008; Jiang, 2016). Over time, there has been greater use of land enclosures to reduce grazing pressure and thereby assist the natural regeneration of grasslands and shrublands in areas where these are more appropriate land cover.

An initial inadequate science base

China's large-scale ecoforestry efforts began just as the country was emerging from the Cultural Revolution, which considerably disrupted many science and resource management systems. The initial science base of the programmes, therefore,

was not well developed, leading to problems such as an overreliance on a relatively small number of species and the use of species that were inappropriate for particular sites.

With the opening of China's economy since the late 1970s, China's capacity in forest sustainability science has developed greatly, and there is growing emphasis on planning and more targeted restoration interventions. Efforts are being made to develop and apply close-to-nature approaches in new plantings and in the ongoing restoration of already-established monoculture plantations (APFNet, 2015, 2019).

Looking beyond the trees to ecosystem function

The need to focus restoration interventions on the right species for a given environment has been alluded to above. Awareness of possible trade-offs is also important, and many authors have shown that successful plantings to arrest erosion on the Loess Plateau and elsewhere caused reductions in streamflow (e.g. Wang *et al.*, 2011; Feng *et al.*, 2017). China is considering these studies to understand how to integrate lessons learned into future projects.

Developing appropriate monitoring and evaluation systems

The development of China's ecoforestry programmes has occurred at a time of rapid economic, social and environmental change, and it is difficult to ascribe the extent to which changes experienced in the programme areas – both positive and negative – are the result of programme interventions or the confounding effects of broader changes. Programme designs that better enable the monitoring and evaluation of results and address trade-offs will become increasingly important, particularly in arid and semiarid areas where the selection of low-cost, water-efficient interventions is crucial.

Sustainable financing of ecosystem services

China's consistent political and budgetary support has been a key element of programme success, but concerns have been raised that reversals could occur when payment periods for key programmes cease or if a significant economic reversal leads to fewer off-farm labour opportunities or population movements back to rural areas (Liu, Yin and Zhao, 2018). Strategies such as the innovative development of payment schemes for ecosystem services and the realization of the economic potential of the forest and agricultural products produced in restored areas will be important for ensuring ongoing public support for restoration and sustainable forest management.

CONCLUSION

Over the last four decades, China's ecoforestry programmes have extended early successes to dramatically expand forest cover and are now focusing on consolidating the ecological services that the plantings were designed to provide. China's experience gives rise to key lessons about what has enabled the implementation of restoration at such an impressive scale. Consistent and strong political leadership was pivotal for supporting long-term governmental and societal commitment to environmental sustainability. This may not easily be replicable in other places, but China's experience shows that consistent policy support can bring about significant progress in the management, conservation, development and restoration of forest landscapes. Multistakeholder, whole-of-society approaches have also enabled the mobilization of efforts across China and helped secure sustainability. Also crucial has been the integration of economic, social and environmental concerns into restoration strategies. Thus, a holistic approach to restoration can support its sustainability and provide diverse benefits.

Learning by doing has been key throughout China's history of forest policy and restoration. It has been backed by ongoing research and development to enable

adaptive management that incorporates new knowledge and responds to challenges. Due to the long timeframe needed for restoration, continuous adaptive learning and implementation is crucial for ensuring the implementation of restoration practices and benefits across landscapes. These key lessons should be taken into account to support the development of sustainable restoration at scale elsewhere.



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