Protection forestry in Northern China

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Abstract

An account is given of some aspects of an international symposium on protection forestry and associated activities during a visit to north China in June 1990. The development and features of the 'Green Great Wall' tree planting project are outlined. Although improved living standards appear substantial through soil stabilisation, better crops and the availability and sale of timber, some criticism is made of the limited choice of tree species and the even age of many district plantings. The visit proved useful in furthering China – New Zealand scientific relations.

Introduction

Accepting an invitation to present a paper at a symposium and to give some post-symposium lectures, I visited northern China during June 1990. The International Symposium on Protective Plantation Technology was organised by the Northeast Forestry University, Harbin, and was attended by 140 participants. The papers selected for presentation were given in Harbin and Zhanggutai, further south, at the Liaoning Sand Fixation Research Station. The meeting's aims were to present information on a wide range of topics concerned with the protective roles of forests and shelterbelts and to inspect representative areas of the various types of plantings that contribute to the 'Green Great Wall' of China.

The inspection covered semi-humid and semi-arid areas north and west of Harbin, the south-east portion of Inner Mongolia and southwards to Beijing. The tour traversed six provinces, from Heilongjiang bordering the USSR to Beijing-Shi and involved road and rail transport over vast distances. Only at the close of the symposium was the reason for this frenetic travel revealed. All six provinces had contributed funds to the symposium and each province was determined to show us their plantings!

The Great Green Wall Project

The NE, N and NW regions of China fringe the Gobi desert and cover 41% of the Chinese land area or nearly the size of Europe. Tree planting in these regions is organised under the 'Three North Project', one of 20 key national projects currently in train in China, and was initiated to provide a barrier against further encroachment by the desert. This immense project started in 1978 and each year some millions of trees are planted. Initially the work was centrally directed but there is now a measure of local autonomy with each district planning, carrying out and reviewing its annual planting programme. Farmers may enter into contracts to plant trees on land owned by the state or collective and obtain a share of the profits. Or they may contract to grow seedling trees in their gardens (Figure 1). The protection system comprises shelterbelt networks on a vast scale, plantations, forests and spaced tree plantings (agroforestry), with the collective purposes of reducing soil erosion, improving crop yields and providing timber for home use or sale.

Figure 1. Seedling tree production in a farmer's garden, Lanxi County, Heilongjiang Province.

The first phase of the project (1978-1985) was mainly to provide farm shelterbelts; the current second phase (to be completed in 1995) aims to protect pasture land, stabilise sandy hills, and establish timber forests. The project, formerly expected to be completed by the year 2000, will continue in 10 year stages until well into the 21st Century. The targeted overall forest cover is 10.6% of the land surface.

The region has a marked continental climate with short, hot summers and long, cold winters. Precipitation decreases from east to west and evaporation decreases in the reverse direction. The eastern portion has 400 to 600 mm rain annually and is the most humid; the centre is semi-arid with < 250 mm rain; and the west has < 50 mm rain. Spring is the driest period of the year with soil moisture and atmospheric humidity at their annual minima. A strong, dry wind blows most of the year with wind damage to crops and grassland frequent in spring. Wind speed, typically, exceeds 17 ms^{-1} on 30 to 60 days per year. The frost-free period ranges from under 100 days to about 200 days. Average annual mean temperatures range from -1°C to -12°C. The soil becomes increasingly sandy (and saline) from east to west. In cultivated areas irrigation relies on underground water or glacial melt-water.

Some Impressions

Unlike some other parts of the world, e.g. West Africa, where the efforts required for arable farming in low rainfall areas are no longer compensated by the yields obtained, no such con-

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straints appear to exist in China. This can be ascribed, in large measure, to the tree planting programme which has stabilised soils, improved crop yields, increased returns to farmers and raised the general standard of living.

Rather open shelterbelts are a feature of North China, commonly five rows of popular with the lower branches periodically removed several metres up the bole. The branches and regrowths provide fuel or occasional feed for animals (Figure 2).

Figure 2. Multi-row shelter plantings of poplar. Regrowth of lower branches, removed for winter fuel, has yet to occur in the upper photograph taken further south, from the Beijing-Moscow express.

Shelterbelts are usually provided on all sides in square networks ranging in size up to 500 m × 500 m, or sometimes disposed to protect narrow cultivated areas of 2000 m × 200 m with the longer belts orientated north:south. Tree spacing is mainly 2 m × 2 m, but is often as close as 1 m × 1 m. Number of rows ranges from two to six.

The openness of the shelterbelts is at first surprising but appears to be compensated by the number of rows, regrowth of cut branches in spring, and by the sheer number of belts which must exert a considerable roughening effect on the landscape and hence significantly modify bulk airflow. The open structure of individual shelterbelts and the deciduous habit assist in distribution of snow in winter, hence improving recharge of soil water. This and the reduction of near-ground windspeed appear to be the main factors benefiting crop yields and thus farmers' incomes.

In NE China poplars are used almost exclusively for the networks because of proven ability to cope with climatic extremes. Reported growth studies showed that *Populus simonigra* (syn.*P.pseudosimonii,* reputedly *P.simonii* x *P.nigra)* and *P.simonii* were among the most suitable poplars. By temperate climate standards the growth of shelterbelts in the semi-humid area is relatively rapid for 10 years, decreasing thereafter and ceasing at year 25 with maturity. The height is then typically about 12 m. Crown forms are satisfactory with moderate and symmetrical spread.

Since 1980 attempts have been made to establish shelterbelts in the middle steppe transition zone between the semi-humid and the semi-arid, seasonal rainfall zones. This lies on hilly land of 300-600 m attitude in western Liaoning Province. Tree species include hybrid poplars, willows, elm *(Ulmus pumila), Robinia pseudoacacia* and pines *(Pinus tabulaeformis* and *P.sylvestris* var *mongolica),* and irrigation is used to aid establishment. The Asiatic race of Scots pine *(P.sylvestris* var *mongolica)* is used as a pioneer afforestation species because of its resistance to cold and drought and adaptability to poor soil.

At the Liaoning Sand Fixation Research Institute at Zhanggatai, in the SE extremity of the Keergin desert, reafforestation began in 1952, using various shrubs, including *Artemesia, Lespedeza* and *Caragana,* to stabilise the sand, followed by trees, the most successful being Scots pine. The Mongolian race here attains 10 m in 28 years.

At this institute, soil nutrients, soil moisture, photosynthesis, and heat and water balances are monitored in sample plots. An unwelcome, but fairly predictable, finding has been the marked lowering of the water table in sandy soils from the growth of Scots pine over a 25 to 30 year period. This conflict between afforestation and ground water levels doubtless pertains at other sites in NE China.

Difficulties with tree establishment in semi-arid areas with small, seasonal rainfall and with soils subject to soil erosion have led to investigations of new techniques for planting Scots pine, including the use of large transplants, outplanted during the growing season in the mid-summer, rainy period. Supplementary water is not then required and survival is reputedly high. For grassland reclamation up to 20% of the land is planted in trees, either in shelterbelts (3, 5 or 7 rows) or in plantations of 4 to 18 rows, with rows 6 m apart, with grazing between rows. Adjacent plantations are separated by 100 m of open pasture.

Methods of growing timber vary according to local needs. Small diameter wood is in greatest demand. Thus densely planted woodlots of poplars at a final stocking of 1200 stems per hectare (s/ha) and Scots pine at only slightly lower stocking were frequently seen (Figure 3). Poplar timber from plantations and shelterbelts is used for general purposes with the upper, rough stems used for roof rafters or pulpwood. Untended birch boles are used similarly. Even agroforestry plantings sometimes contain as many as 800 s/ha. Only where logs were the end product was final stocking reduced to 150 s/ha.

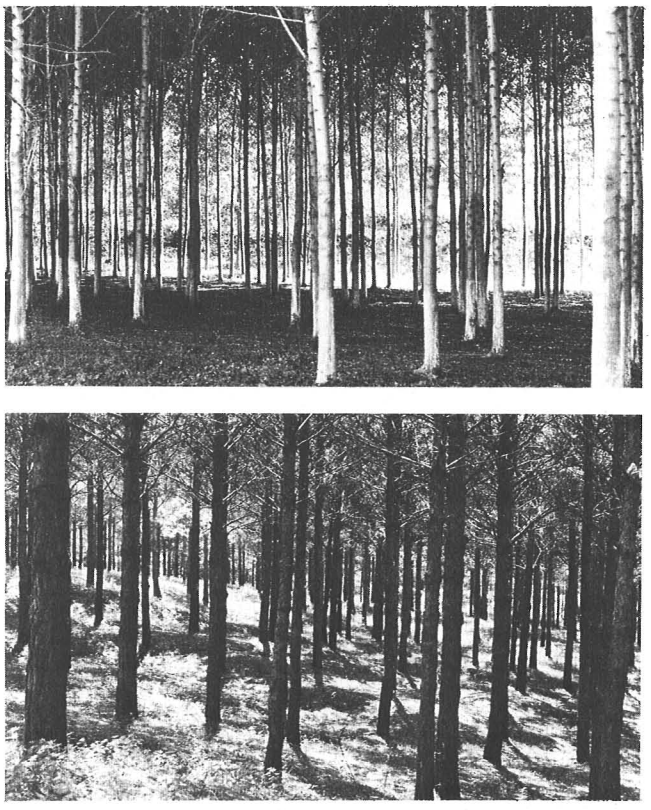

Figure 3. Farm woodlots of hybrid poplar (above) and Scots pine (below).

At the Saihanba Forest Farm, between 1000 m and 2000 m altitude in Hebei Province, production forestry uses larch *(Larix gmelina),* Scots pine and a limited amount of spruce. Since 1975 replanting has been at 450 s/ha and for some end uses the final stands will be 150 s/ha. Annual growth increments average 0.5 m, which is creditable with only 70 growing days per year at this site, and an annual average temperature of -1.4°C, a maximum summer temperature of 30°C and a minimum winter temperature of -43°C. Little is wasted here or, for that matter, in China generally. Thinning to waste is unheard of, and small roundwood is marketed (Figure 4). Saihanba also functions as a training school for foresters.

Figure 4. Small round wood being transported from the 45,000 ha Saihanba Forest Farm just south of the Inner Mongolia border.

Conclusions

One leaves China with an image of prodigious tree planting on an almost unimaginable scale, such is the determination of the Chinese to protect their vulnerable northern pasture and arable lands. The hardiness of poplar hybrids, Mongolian pine and other species to cope with temperature extremes was impressive. At the same time many of the techniques used, especially those connected with establishment, are labour intensive and would be quite uneconomic outside China. Indeed, the scale of planting within the 3 N system is probably only possible through a centrally-driven economy and a fairly doctrinaire bureaucracy, aided by the fact that in China, as a whole, 70% of the economically-active population work on the land.

For the shelter networks, in particular, the choice of species seems dangerously limited. Many of the plantings are also even-aged. Although the health of poplars – the invariable choice for shelterbelts – is currently excellent (and contrasting with the general position of poplars in the United States), there is an obvious need to increase the range of species used in windbreak plantings. This is being acknowledged by the Chinese who are planning to widen the species base. Methods of regeneration will also have to be considered for the even-aged networks. The quality of tending needs improvement where commercial timber is the planned end use.

The visit was well worth while. As others have found, the Chinese are friendly and courteous, often with a well-developed sense of humour. They are receptive to new ideas and eager to learn, but adoption of new technology is often constrained by limited resources. It was gratifying to have the shelter expertise that the DISR Fruit and Trees is able to offer such regions, confirmed.

Acknowledgements

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Research project will show effect of forests on carbon dioxide

Scientists at the Forest Research Institute (FRI) at Rotorua have begun a research project funded by BP Forests New Zealand Ltd, to discover how effective forests are at capturing and holding atmospheric carbon dioxide.

Project leader Dr David Whitehead points out that levels of carbon dioxide in the atmosphere have been increasing since the beginning of the industrial revolution. These increases, together with contributions from other "greenhouse gases," will bring about changes in climate which are likely to have significant effects on many aspects of life on the planet, including forest ecosystems.

"The project will serve a double purpose," he said. "On the one hand we want to discover the effect of increased levels of carbon dioxide on forest growth, and on the other we want to assess how much carbon dioxide might be taken up and stored by forests."

The possibility of using forests to absorb and store carbon has prompted BP Forests Ltd to fund the project.

"A responsible company must be prepared to counter any form of environmental threat its operations might pose, and this gives rise to the concept of offset forestry," said BP Forests Manager Mike Fulcher.

"From this work we hope to gain an indication of the area of new forest planting that might be required to mitigate the effects of emissions from fossil fuels."

So far studies in this area have been confined to short-term trials based on seedlings or young trees in small pots, but the new FRI work will involve mature trees over a longer term, and the results will be more easily applied to real forests.

"This kind of study is possible only because of FRI's unique growth rooms," said Dr Whitehead.

These rooms allow scientists to grow trees up to seven metres tall in a controlled environment. In the trial, one room has a normal level of carbon dioxide, and the other has double the normal level. The amount and quality of light, the temperature and humidity and the amount of moisture available to the trees is identical in both rooms, and the trees' growth response is being recorded.

"The results of the experiment should enable us to refine predictions of the growth of forests and the amount of carbon that will be taken from the atmosphere and stored by each hectare of new forest, in conditions expected to occur by the middle of next century," said Dr Whitehead.

"If our earlier work is confirmed, we will be able to show that New Zealand has enough unproductive, unforested land available for new plantations to be able to counter our artificial carbon dioxide emissions for the next 50 years. That is 50 years of time 'bought', during which practices can be changed, and measures taken to reduce man-made emissions."

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