

Wind Erosion Control with Shelterbelts in North China¹

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THE merits and applicability of shelterbelts to control wind erosion in North America have been somewhat controversial. Not so the experiences in some regions of China, where under some conditions windbreaks of trees or shrubs are almost the sole means of coping with the blowing of sand by wind. Because they may be of interest to those technicians charged with the planning and care of windbreaks on this continent, a few observations made in northern China are reported briefly herein.

Wind eroded sands have long presented a problem in Honan, Anhwei, and Kiangsu provinces in North China. Much of the sandy area is located in and near the broad flood plains of the Yellow and the Hwai rivers. The Chinese farmer in these areas has been faced with blowing sands for centuries. Many evidences exist to show that he fought a losing battle. The present sites of such cities as Kaifeng, Chungmou, and Loyang are comparatively new; the old sites appear buried under many feet of silt and sand. At the present time great active sand dunes are encroaching upon Kaifeng, the capital of Honan, from the north. Much of the 300-year-old brick wall, 50 feet in height, and an area within the wall are already covered by sand dunes. The city dwellings now extend beyond the historic wall to the south and east, away from the encroaching sand dunes.

The greatest handicap to permanent control of sands is the intense pressure of population for agricultural land. Every bit of vegetation that is grown is utilized either for food or fuel. Consequently, little organic matter is returned to the land, except in a digested form. Under such conditions the land is denuded, and the soil, unless protected by some means, drifts easily with the wind.

One of the main agricultural problems in North China at the present time is the reclamation and control of sandy lands formed since the last break of the Yellow River through its levees in 1938. The break caused great damage to life and property. The flood waters inundated, in 1938, more than 2 million acres of rich agricultural land occupied by about 700,000 population. About two-thirds of the people were able to escape the floods; the rest drowned.³ Large quantities

of silt and fine sand were deposited over the land by the flood waters, the depth of deposits varying from 1 to 15 feet, depending on locality. The location of the flooded area has since varied considerably from year to year due to continual shifting of the flowing waters.

When in March, 1947, through the efforts of UNRRA and the Chinese government the Yellow River was diverted to its former course which is protected by huge levees all the way to the sea, numerous sandy stream beds, resulting from the meanderings of the flood waters, were exposed throughout the devastated region. These sandy areas soon dried up and became extremely susceptible to erosion by wind, thus forming a serious menace to agricultural land nearby.

These stream bed sands created a serious problem; but there were other sandy soils near the Yellow and Hwai rivers causing difficulties fully as great. The most important of these is the sand dune area near Kaifeng, about one-quarter of which has been flooded and resorted by the Yellow River since 1938. Much of the fine sand has been transported from this area south-eastwards almost to the Hwai River. The sandy lands not recently flooded by the Yellow River but needing similar reclamation work for their fuller utilization cover a much greater area. In addition, there are some sand dune areas in Anhwei Province mostly concentrated along the Hwai River, though formed as a result of the flood waters of the Yellow River. Considerable sand accumulations, some of which are bare and drifting with the wind, also occur along the whole pre-1852 course of the Yellow River in Honan and Kiangsu provinces. Another large area of wind-eroded sandy land, perhaps fully as large as that adjacent to Kaifeng, occurs in western Honan and Shensi provinces, particularly near the junction of the Han and the Yellow rivers.

A unique system of sand dune protection and utilization has been developed near Kaifeng, the present capital of Honan Province. This system perhaps is not duplicated anywhere else for its magnitude and effectiveness. The farmers have solved the problem by growing single rows of trees at regular intervals across the landscape. It was found that single rows of shelterbelts fitted better into the program than double or multiple rows, because they occupied the least amount of space for the amount of protection derived from them. The belts supply fuel and building and wicker material for the local population and also for the population of the nearby city of Kaifeng. At the same time they give adequate protection to the soil from the wind.

The belts are planted at fairly close intervals. This

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interval varies somewhat with the degree of susceptibility of the soil to wind erosion and with the density and height of the belts. Single rows of willows located not over 50 to 60 feet apart running north and south or east and west are the most common type of planting. Belts are also run, at right angles to the general direction. The space interval between these varies anywhere from 100 to 500 feet or more, depending on the size and shape of the individual parcels of land. The margin of each parcel of land is usually marked by a shelter belt.

The question of how far apart the belts can be spaced and still give complete protection to the soil from wind seems to have been worked out through long experience by farmers themselves. The system apparently has been practiced for many generations, so it is definitely beyond the experimental stage. Nowhere else perhaps are trees and agriculture so intimately associated as in this region, which roughly covers a distance of 25 to 30 miles east, south, and west from Kaifeng.

It was found that the denser the belts the greater is their protective quality, but to a certain limit only. A certain amount of porosity is found unobjectionable. Dense undergrowth is usually thinned out for fuel.

The more erodible the soil, the closer together the shelterbelts are planted. Complete effectiveness of the shelterbelts is assumed to depend on reducing wind velocity below that required to initiate soil movement throughout every portion of the area between the belts. In order to be effective against wind action shelterbelts situated on very sandy soil, such as that around Kaifeng, must reduce the wind velocity to below 10

miles per hour at 1 foot height or by at least one-half. A 50% reduction in wind velocity near a dense, single-row willow belt occurs, under average conditions, somewhere in the neighborhood of 6 to 7 tree heights to leeward along the direction of the wind. The average willow belt is about 12 feet high; consequently, the effectively protected zone, if the belts run at right angles to the direction of the wind, would be 6 to 7 times this figure, or 72 to 84 feet in width. The average distance between willow shelterbelts now established in the Kaifeng area seems to be somewhat smaller than this, probably because the prevailing winds are from the northwest or the southeast, whereas the belts generally run north and south and east and west.

Belts consisting of low bushes, such as *Tamarix*, are planted about 20 feet apart. In some cases tall trees are established and are provided with an undergrowth of lower, more bushy species. Such belts are placed much farther apart, but because they are more difficult and costly to establish they are not numerous. Where grown, they are apparently justified mainly on the basis of timber production.

The space interval between individual trees in a belt varies considerably, depending on the species used. Low, bushy types, such as *Tamarix*, are planted about 1 foot apart in single rows, willows 1 to 3 feet apart, and poplars and other tall-growing trees 4 to 8 feet apart. Wherever tall trees are grown, low, bushy species are planted between for additional protection near the ground.

The shelterbelt system adopted near Kaifeng fits well with existing climatic and economic conditions. Rainfall is relatively high, 28 to 40 inches per annum, sufficient for luxuriant growth of trees, including willows. Topography is, on the whole, level, which is



FIG. 1.—Single rows of willow and poplar planted along the margin of a field 400 feet long and 60 feet wide have given virtually complete protection to soybeans planted on alluvial sand near Kaifeng, China.



FIG. 2.—Peanuts planted between rows of *Tamarix* spaced 20 feet apart are completely protected from wind erosion of alluvial sand in the Kaifeng district of China.

quite suitable for shelter belt plantations. The water table is generally very near the surface and facilitates vigorous growth of trees. The trees, therefore, compete but little for moisture necessary to grow crops adjacent to and between the belts. The sandy soil also encourages good tree growth.

Shelterbelts have become an important method of wind erosion control in Honan and Anhwei, mainly due to inability of the farmers to find other suitable methods. Due to the real need for vegetative materials for fuel and shelter, these materials, including roots, are removed from the ground. The maintenance of a high content of soil organic matter and the use of a vegetative litter for protection from wind is almost impossible under the circumstances. Strip cropping, though not considered as such, is in effect in existence in China by virtue of excessive farm fragmentation. However, neither strip cropping nor cover crops, singly or in combination with other cropping methods, is sufficient for the protection of very erodible sands. Yet in China these sandy soils must be cultivated in order to produce the needed requirement of food, fuel, and shelter. So far, the shelterbelt system has been found to be the only real solution.

The formation of bare sandy areas by the flood waters of the Yellow River between 1938 and 1947 created a great problem for the destitute population. In view of the urgent need for the production of food for the people who swarmed back into the devastated areas following the diversion of the Yellow River to its pre-1938 channel, personnel and funds were made available by UNRRA and the Chinese government to carry out a program of reclaiming these lands for agricultural use. The best plan appeared to make use of the system that has been established so effectively in the Kaifeng area, namely, the planting of willow shelterbelts at regular intervals in a checkerboard system across the landscape.

The program in both Anhwei and Honan provinces was initiated in 1947, and by the end of the planting year shelterbelts had been established over 14 thousand acres of land. These shelterbelts, composed almost entirely of willows, were planted every 50 to 70 feet apart on very sandy land. The farmers supplied the willow cuttings and did all the planting. For every 50 cuttings planted, that is for every mow of land ($\frac{1}{6}$ acre) protected, they received 4 catties (about 5 pounds) of wheat as payment for labor and material. Two catties of wheat were given for each mow soon after the farmer agreed to do the planting and 2 catties after the planting was completed. The farmers were, on the whole, interested in doing this work. Some of the interest was, no doubt, due to the opportunity for earning some wheat, which they needed for food and seed; however, there was also a genuine interest in establishing the shelterbelts for the much-needed protection of homes and fields.

In addition to the installation of shelterbelt plantations, some work was carried out on a similar basis in tying down active sand dunes. The problem of reclaiming dune areas is much more difficult and requires more labor and time. First the dunes are leveled down somewhat. Following this first step the whole surface is tied down either by planting suitable sand grasses or by spreading koaliang stalks or other vegetative material over the surface. Once sand drifting has ceased, the whole area is planted to crops. Shelterbelts are then planted according to a system found most suitable for the conditions in question.

Because the extent of the sandy regions is large, it was advisable to start work in nucleus areas only. These areas served as demonstrations of effective methods. It is anticipated that they will grow in extent as funds, materials, and personnel become available and as interest on the part of the farmers and local organizations is developed.

Approximately ten technical and clerical personnel were employed initially to carry out the program in each of the two plantation regions established. Money and materials were handled by the Chinese National Relief and Rehabilitation Administration (CNRRA) under the direction of the Officer-in-Charge for a particular region. The program was under the general direction of the Ministry of Agriculture and Forestry. Close consultation and cooperation with CNRRA and UNRRA staffs was maintained throughout the existence of these two agencies.

The shelterbelt planting program initiated in 1947 was on a comparatively small scale in relation to the total area needing reclamation. It was difficult, if not undesirable, to launch an extensive program of this type immediately. Its scope should increase as funds and personnel are made available for general administration. It is a program which must have continuity for at least a period of years to be really successful.

Summary

In some regions of North China shelterbelts have been used for many generations to protect very sandy land from erosion by wind. The method consists of growing trees or bushes in single rows 20 to 60 feet apart in one direction and 100 to 500 feet or more apart at right angles to this general direction. The whole landscape is thus divided into small rectangular fields protected by shelterbelts on all four sides.

Extensive areas of bare, wind-swept sands created by the flood waters of the Yellow River during the recent war years presented a great problem for the destitute population. UNRRA and the Chinese government carried out a program of planting willow shelterbelts in accordance with the established local practice in order to reclaim such lands for agricultural use.