2-1936

Planting and Care of Trees in South Dakota

E. R. Ware

Extension Circular 356 February 1936

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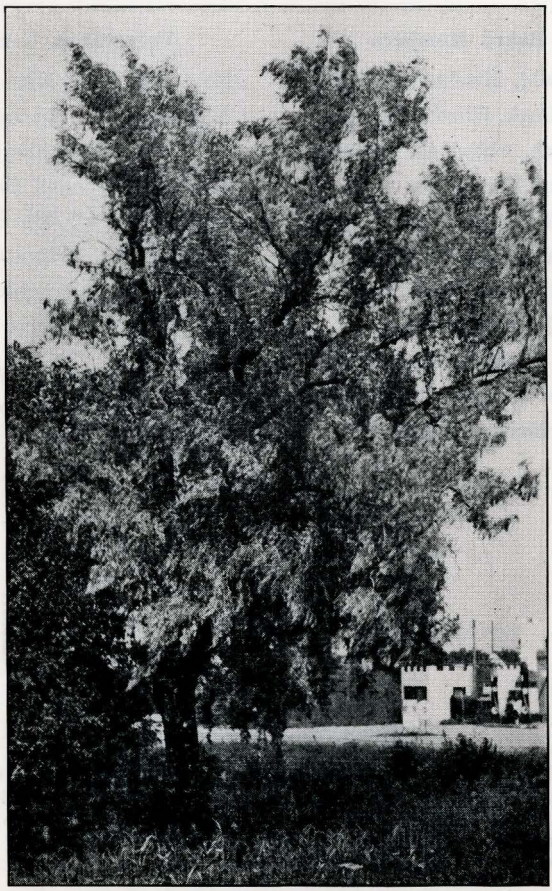

Fig. 1.—Large specimen of a Russian olive tree.

SOUTH DAKOTA STATE COLLEGE
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EXPLANATION OF COVER CUT

Fig. 1.—Large specimen of a Russian olive tree growing south of Sioux Falls in Minnehaha county, which is 40 feet high and 21 inches in diameter (measured 4½ feet from the ground). Ordinarily this tree reaches a height of 10 to 20 feet. Russian olive is exceptionally hardy under severe climatic and soil conditions and is one of our most desirable trees for farmstead shelters and windbreaks.

Foreword

During 1935 a survey of forest resources of South Dakota was sponsored by the Forestation Committee of the State Planning Board. The survey was made to determine the present condition of planted trees and the methods of establishing and caring for plantations which will insure success in spite of periodic dry weather. The need of additional planting was studied.

The project was made possible by the deep interest in forestry problems of the state shown by Col. Allen S. Peck, regional forester, United States Forest Service, Denver, Colorado; Raphael Zon, director of the Lake States Forest Experiment Station, St. Paul, Minnesota; and Paul Roberts, director of the Plains Shelterbelt Project, Lincoln, Nebraska.

The work was carried on under a cooperative agreement between the State Planning Board, Region 2 of the United States Forest Service, and the Lake States Forest Experiment Station.

The section of the report dealing with recommended methods for the planting and care of trees for farm purposes is embodied in this Extension Service circular.

Information from the publication "Possibilities of Shelterbelt Planting in the Great Plains Region" by the Lake States Forest Experiment Station, was made available and freely used. The Indian Service contributed field assistance within Indian reservations.

H. C. Severin, state entomologist, supplied a list of insects which attack broadleaf trees in South Dakota and supplied other information. Dr. W. A. Riley, head of the entomology department of the University of Minnesota, and his staff, gave helpful suggestions regarding control of insects.

Carlos G. Bates, R. N. Cunningham, and J. H. Stoekeler, of the Lake States Forest Experiment Station, St. Paul, Minnesota; Dr. N. E. Hansen, horticulture department, South Dakota State College; and E. J. George of the Northern Great Plains Field Station, Mandan, North Dakota, and the Plains Shelterbelt Project, gave valuable information. and suggestions.

Funds and labor were also available for the work east of the Missouri river from state work projects in which valuable cooperation and assistance was given by M. A. Kennedy, state relief director, and the director of relief in each county.

Members of the Forestation Committee of the State Planning Board under the chairmanship of Robert D. Lusk gave freely of their time and contributed much toward the success of the project.

C. W. Pugsley, President
South Dakota State College

Facts on Tree Planting

Number of Plantations in South Dakota	
Farmstead shelters	38,180
Field windbreaks and woodlots	8,500
School shelters	320
Total	47,000
Area of Planted Trees	
Acreage of planted trees	86,000
Size of Plantations	
Average size of all plantations	1.83 acres
Average size of farmstead shelters	1.70 acres
Average size of field windbreaks and woodlots	2.45 acres
Range of sizes studied	0.1 to 40 acres
Age of Plantations	
Fifty-one per cent of plantations	30 years or over
Oldest plantation found	80 years
Timber Culture Act Plantations	
Average age	51 years
Oldest Timber Culture Act plantation found	60 years
Per cent of original plantations remaining	24
Per cent of original acreage remaining	12.5
Volume of Plantations	
Total volume of wood	924,000 cords
Average volume of wood per acre	10.7 cords
Growth per acre per year	0.25 to 1.0 cords
Annual Cut of Wood from Plantations	
Fuel wood	50,000 cords
Fence posts	33,000 posts
Lumber	300,000 board feet
Condition of Trees in 1935—All Plantations	
Living	55 per cent
With dying top branches	26 per cent
Dead	19 per cent
Trees Hardy Throughout the State	
Eastern red cedar	Chinese elm
Rocky Mountain red cedar	Green ash
Ponderosa pine	American elm
Hackberry	Honey locust
	Bur oak

Homes: Forty-six per cent, or less than half, of farm homes have farmstead shelters.

Farms: One out of every two farms has a tree plantation. There is 1 acre of planted trees to every 200 acres of crop land.

Schools: Only one out of every 14 schools has a tree shelter.

Parks: South Dakota has one acre of municipal parks to every 62 residents.

Planting and Care of Trees In South Dakota

By E. R. Ware*

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Development of Tree Planting

Usually the first improvement made by the pioneer in this state after he had built his home and put in his first crop was to plant trees for the protection of his home. Early settlers arrived in the '50's and '60's and by 1890 the eastern third of the state was largely taken up.

As early as 1869 Dakota Territory passed a law exempting from taxation 40 acres of land and all improvements thereon not exceeding $1,000 in value provided 5 acres of land were planted to trees. The exemption was for 10 years provided the trees were kept in good growing condition during that time.

In 1885 the first tree bounty law was enacted. It was reenacted at the first session of the South Dakota Legislature after attaining statehood and although revised a number of times this law is still in effect today. It provides that any person who plants and cares for trees as prescribed

* Assistant Supervisor, United States Forest Service, and Forest Consultant to the State Planning Board.

by the law shall be entitled to a bounty of $5 per acre, on not to exceed 10 acres, each year for a period of 10 years, to be paid by the board of county commissioners of the county in which the trees are located.

The number of persons receiving tree bounties in the state has greatly increased during the past 7 years. A study of payments made by counties over the state disclosed that 79 bounties were paid in 1929 as compared with 501 in 1935. During this same period the acreage increased from 244 to 1,325 acres.

The Timber Culture Act passed by Congress in 1873, provided that a person could obtain title to 160 acres of land by planting 40 acres of it with trees, and these not to be spaced more than 12 feet apart. An amendment in 1878 reduced the area to be planted from 40 to 10 acres. The final entry for South Dakota under this act amounted to 2,124,754 acres; an additional 121,891 acres were commuted. The survey figures disclose that 17,108 acres of timber remains of the original plantations made under this act. One-fourth of the plantations and one-eighth of the original acreage is still in evidence on the ground.

The Timber Culture Act was repealed in 1891. The population of the state continued to increase rapidly until 1910. A period of exceptionally high rainfall from 1900 to 1910 occurred, which was very favorable to tree growth. Consequently, there was no decline in tree planting although it was now carried on largely by private initiative. The ages of individual plantations, as disclosed by the 1935 survey, indicate clearly that since 1915 there has been a steady decrease in the number of new plantations.

The Northern Great Plains Field Station of the Bureau of Plant Industry, Mandan, North Dakota, has developed excellent methods for the planting and care of trees in the Great Plains region. Since 1916 this station has established 763 cooperative tree plantations in South Dakota, all of which are located in the western part of the state. The work of this station is strictly experimental and trees are not furnished to farmers for general distribution. The station is doing invaluable work in supervising the establishment of tree plantations in a part of the state where conditions for growing trees are generally difficult.

In 1933 a law was enacted which enabled the state Secretary of Agriculture to take advantage of the federal funds for tree planting available under the Clarke-McNary Act of June 1924. The Clarke-McNary Act authorizes the United States Department of Agriculture to cooperate with the various states in the procurement, production, and distribution of forest tree seeds and plants, for the purpose of establishing windbreaks, shelterbelts, and farm woodlots on denuded and nonforested lands. The law stipulates that the amount expended by the Federal Government shall not exceed the amount expended by the state for the same year.

Under this law 124,425 trees were sold to 379 persons in 1934 and 137,500 trees were sold to 506 persons in 1935. This method of distributing trees is popular and has proven effective.

The recent drought period which started in 1924 and reached its climax in 1934, coincides closely with the country-wide economic depression. For the purpose of creating permanent improvements to alleviate the effects of drought upon agricultural activities in the Plains States and at the same time to relieve unemployment, the Federal Government established the Plains Shelterbelt Project in 1934. During 1935, 3,300 acres of trees

were planted on 1,057 farms, and this amount will be materially increased in 1936.

This project, because of the well grounded scientific approach to the problems involved, gives promise of developing into one of the most beneficial tree planting programs for plains conditions ever undertaken.

The state departments of Public Instruction, Game and Fish, Highway, and School and Public Lands have all contributed to tree planting activities. Many county and city governments and civic organizations have been especially active in planting and distributing trees to both city and rural residents.

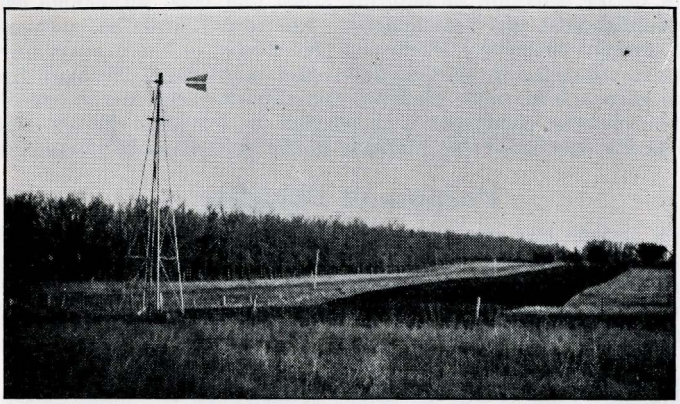

Fig. 2.—48 year old tree plantation made under the Timber Culture Act of 1873. The trees are from wild seedlings and the plantation extends for one half mile along the west side of the tree claim.

While the various Federal and State laws have encouraged and at times marked the way for the planting of trees in South Dakota, it is significant that a very large number of the 47,000 individual tree plantations in the state are the result of personal effort. The amount of planting in the past has been insufficient for the actual needs. With the active cooperation and direction from the government in tree planting, the individual efforts, which were not always successful, will increase in amount and be carried out along lines guaranteeing greater success.

It is evident, however, that the field is so tremendous that public agencies alone will not meet all demands.

Present Condition of Tree Plantations

Losses in tree plantations due to drought have not been so great as generally believed. Studies of plantations disclose that 55 per cent of the trees in plantations are in a healthy condition. An additional 26 per cent are still living but have a varying amount of dead top branches. A large per cent of these trees will live on indefinitely. Only 19 per cent are actually dead.

The noticeable losses occurring during the past several years have been due to a combination of drought and other factors.

The planting of species of trees not hardy to the state in general and

too upland planting sites in particular has resulted in much loss. A large per cent of the older groves were planted with the fast growing and less hardy species such as boxelder, cottonwood, and willow.

Many of the older plantations are dying because of age. The trees on some timber claims have attained ages at which many of the species, especially the less hardy ones, are mature or overmature.

Lack of proper care greatly affects the health and vigor of trees. The neglect of cultivation during the early years and subsequent use for grazing creates soil conditions which are very detrimental to tree growth. These conditions result in weakened trees which are more susceptible to attacks of insects and diseases.

With better selection of planting stock and with reasonable care in their establishment and management, plantations will be safeguarded against drought conditions. There is a great need at the present time for planting to offset the inroads made on tree plantations. Through the experience gained from early planting and the increased knowledge of soil types and climatic conditions it is possible to set forth definite lines of procedure for successful tree planting in the various parts of the state.

Purpose of Planting

South Dakota has approximately 47,000 tree plantations which cover a total of 86,000 acres. They vary from 1/10 to 40 acres in size. Of the total number, 38,150 are farmstead shelters and 320 are school shelters averaging 1⅔ acres each. There are 8,500 windbreaks and groves averaging 2½ acres in size.

Fig. 3.—Interior view of the plantation in Fig. 2, which is a pure stand of green ash originally planted with a 4 by 4 foot spacing.

About one out of every two farms has a plantation. They occur more frequently in the southeastern part of the state, the number and size decreasing northward and westward. Practically all of the eastern part of the state is in farms, and tree plantations are general throughout. Large sections of the western part are devoted to grazing and livestock production and plantations occur usually in the restricted agricultural areas.

In the eastern half of the state there is 1 acre of planted trees for every 165 acres of crop land. In the western half there is 1 acre of planted trees for every 960 acres of crop land. For the entire state there is 1 acre of planted trees for every 200 acres of crop land or one-half of one per cent in tree plantations.

Every farm home should be protected from the wind by a farmstead shelter. In addition there should be a woodlot and field windbreaks to afford some crop protection. Unless favored by the occurrence of native woodlands, at least 5 acres on each 160 acres of crop land should be devoted to the growth of trees.

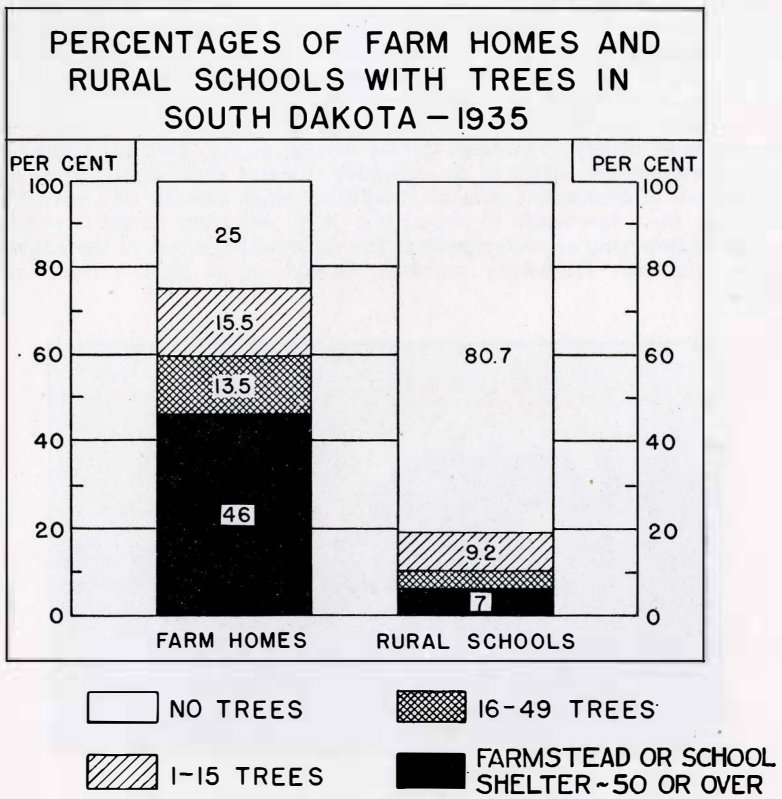

Fig. 4.—Only 46 per cent of farm homes and 7 per cent of rural schools have sufficient trees to afford some wind protection.

Farmstead Shelters. By planting trees farmers have protected their homes and livestock from the cold winds of the winter and from the hot dry winds of the summer. Trees provide more pleasant and comfortable surroundings throughout the year and are an important item in lessening the winter fuel bill.

For every five tree plantations in the state four are for the protection of the farm buildings and one for a windbreak or grove. Only 46

per cent or less than half of the farm homes of the state have farmstead shelters.

Gardens and orchards are ordinarily planted adjacent to farmstead shelters or surrounded by a few rows of trees. Both are benefitted by the additional moisture added to the soil which is trapped in the form of snow. Orchards on the north and east of trees are protected from the sun during warm periods of the winter and spring and prevented from starting premature growth and flowering which often results in the loss of a fruit crop from late frosts.

Field Windbreaks. It has been demonstrated that trees retard the velocity of the wind for a distance approximately 20 times the height of the windbreak. This lessens evaporation from the soil and during the winter months brings about the accumulation of more snow than normal in the zone of influence. With the exception of a narrow strip adjacent to the trees, crops which are planted on the leeward side of a windbreak grow under more favorable conditions than if unprotected. Windbreaks are the most beneficial to crops during periods of dry weather. Trees will not counteract the effect of an extended drought. Frequently, however, the periods of destructive climatic conditions which actually destroy crops, last only for a few hours to one or two days, and occur during a critical period of flowering or seed ripening. The temperizing effect of trees under these conditions frequently prevents damage or at least a total crop failure.

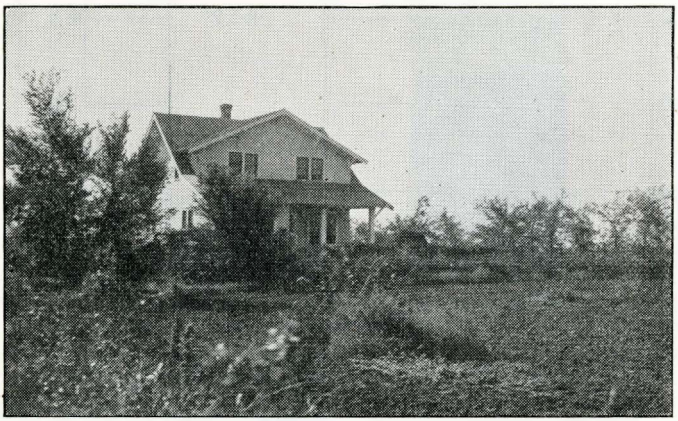

Fig. 5.—A beautiful home in Corson county. The owner surrounded his home with several acres of trees and despite very dry conditions, proper tillage methods have insured successful tree growth.

Woodlots. Every farm has waste areas that are too rough or wet for farming but ideally suited to planting of fast growing tree species for the production of fuel and other wood products. Non-productive land, if used for growing trees, ceases to be a liability and contributes to the farm income and materially increases its value. Cottonwood and other fast growing trees will produce from one-quarter to one cord of wood per acre annually, depending largely upon soil moisture conditions.

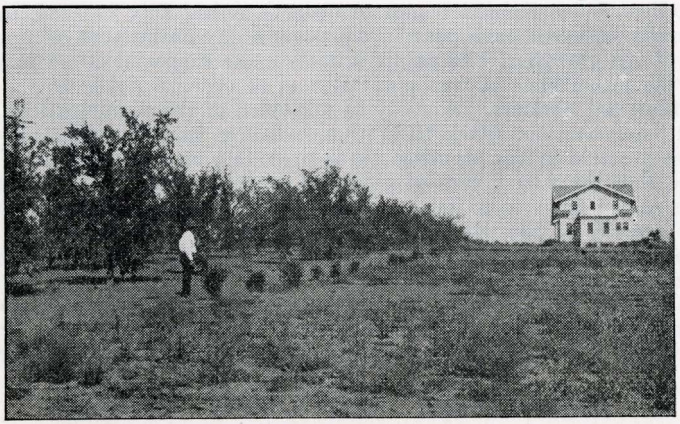

Fig. 6.—Farmstead shelter of American elm trees. These trees are from wild seedlings which have been planted 10 years. Note the clean cultivation beneath and at the edge of the trees. The soil is fine textured and the average annual rainfall in this region is about 17 inches. Corson county.

The trees planted for a farmstead shelter should not be considered as a source of fuel wood and only the dead trees should be removed.

School Shelters. Only one out of every fourteen rural schools is provided with a tree shelter. Besides adding much to the comfort of the schools and the beauty of the grounds, tree plantations provide many educational features in the training of pupils to recognize the different kinds of trees and in the proper methods of their planting and care. The study of bird and animal life is made possible by the attraction of these animals to tree plantations. A program to stimulate tree planting around rural schools offers great opportunities and is badly needed.

Arbor Day. This day was first observed by Nebraska on April 10, 1872, and is observed today by every state in the Union and 11 foreign

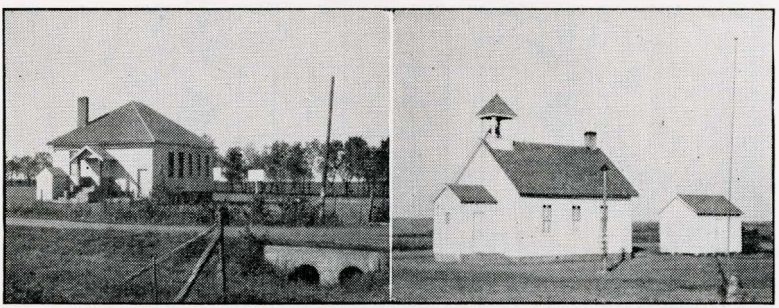

Fig. 7. Left.—Rural school protected on the north and west by planted trees. The grounds are made attractive and comfortable and their value for recreational purposes enhanced. Right.—Rural school without trees. Every permanent rural school in farming regions of the state should be provided with an adequate tree shelter. The trees should include a plantation at least 100 feet wide and long enough to protect the school grounds on the north and west sides.

countries. South Dakota began to observe Arbor Day in 1884 and it is generally observed each year in April, on a day designated by proclamation of the governor. The public schools make a special effort to emphasize the importance of tree planting and to observe Arbor Day.

Municipal Shelters. A study of one-third of the municipalities of the state, excluding the Black Hills area, indicates that the cities and towns are very active in tree planting and in providing recreational parks. It was found that there is 1 acre of park for every 62 residents. This included some native trees in a few instances. This average compares favorably with records of the National Resources Board, which indicates that a national average is 1 acre to every 208 persons. This Board recommends a ratio of 1 acre for each 100 persons.

Although the average figures are somewhat favorable it does not mean that there is no need for municipal tree plantations or an increase in acreage of existing trees, for there are many cities or towns far below

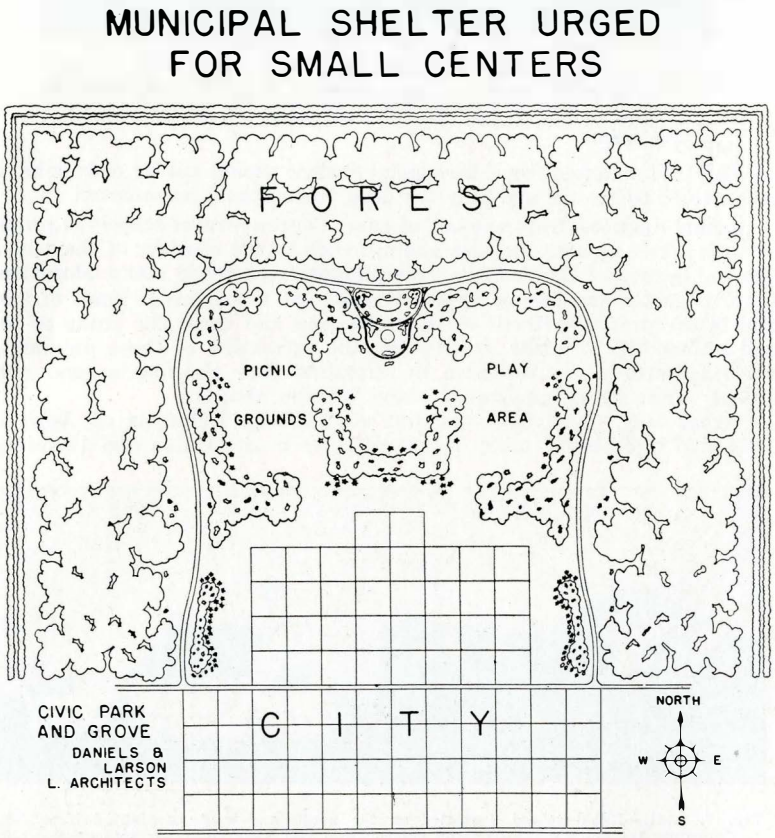

Fig. 8.—A sample plan for a municipal shelter or grove which aids in beautifying the community, tempers the effect of both summer and winter winds, and provides picnic and recreational grounds for summer and winter sports. Courtesy Daniels and Larson, landscape architects, Valley City, North Dakota.

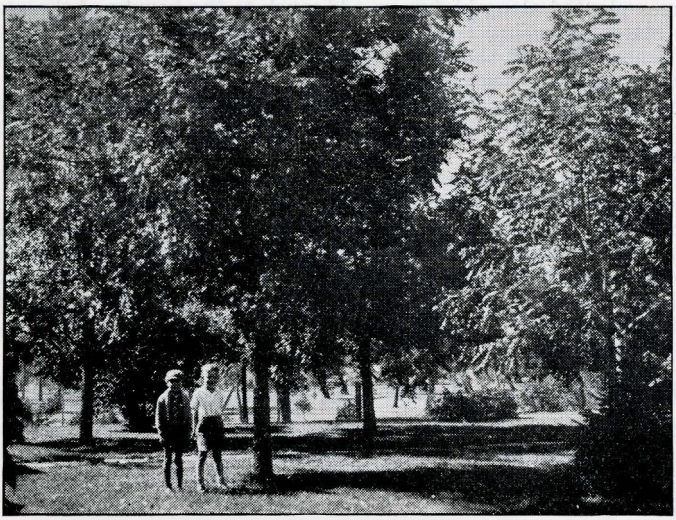

Fig. 9.—Municipal park scene at Pierre, South Dakota. The black walnut trees in the center are nine years old and have been bearing nuts for two years.

the average or without any parks or groves whatsoever. At a relatively low cost, cities and towns without municipal plantations may add to their attractiveness, to the opportunities for outdoor recreation of their residents, and to protection from wind and snow, through the establishment of tree plantations. Fig. 8 is a sample plan suitable for municipal shelters and groves. This is one of the most beneficial types of municipal development.

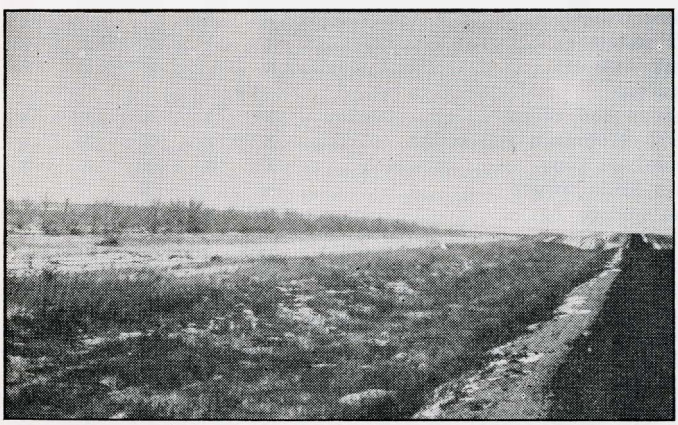

Fig. 10.—Two-row Russian olive snow fence along a Wyoming highway, near Cheyenne.

Trees planted along highways add much to the beauty of the roadside. Some states are using trees extensively along highways in the place of snow fences. Fig. 10 shows a two-row Russian olive snow fence along a Wyoming highway near Cheyenne.

The planting of trees and shrubs for the control of soil erosion caused by wind and water is undertaken by the Soil Conservation Service in South Dakota.

The stability of the farming industry in South Dakota depends upon the permanence of the individual farm homes. If by means of tree planting the efforts of the farmer are made more successful; if daily living conditions can be made more attractive and comfortable; if the social and spiritual value of the trees raises the general level of living conditions and morale of the people; then the objective of rural life which, after all, is to provide the highest plan of living that the land will support, is more closely approached.

Tree Planting Zones and Recommended Species

The state has been divided into six zones, each of which presents its own special problems in tree planting, as revealed by the growth and adaptability of the more important kinds of trees. Fig 11 is a map of the tree planting zones.

Of the 35 kinds of trees and shrubs studied in tree plantations, the 23

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Broadleaves						
Hackberry	x	x	x	x	x	x
Chinese elm	x	x	x	x	x	x
Green ash	x	x	x	x	x	x
American elm	x	x	x	x	x	x
Honey locust	x	x	x	x	x	x
Bur oak	x	x	x	x	x	x
Native cottonwood	x	x	x	x*		x
Boxelder	x	x*	x			x
White willow	x	x*	x			x
Soft maple	x		x			
Black walnut	x		x			
Evergreens						
Eastern red cedar	x	x	x	x	x	x
Rocky Mountain red cedar	x	x	x	x	x	x
Ponderosa pine	x	x	x	x	x	x
Black Hills spruce	x	x	x			x
Blue spruce	x	x	x			x
Tall Shrubs						
Russian olive	x	x	x	x	x	x
Caragana	x	x	x	x	x	x
Chokecherry	x	x	x	x	x	x
Buffalo berry	x	x	x	x	x	x
Wild plum	x	x	x			x
Low Shrubs						
Common lilac	x	x	x	x	x	x
Tartarian honeysuckle	x	x	x	x	x	x

* On sandy soils with high water table level only.

Fig. 11.—Tree planting zones. Each zone presents its own set of climatic and soil conditions. The more hardy species grow successfully throughout the state while other succeed only under the most favored conditions.

considered here were found to be the most satisfactory for planting within the state. The list on page 14 divides species into four groups: broad-leaves, evergreens, tall shrubs and low shrubs, with the species in each group listed in order of their hardiness. The x's indicate the zones in which each species is found to be successful.

Survival figures indicate clearly that the two cedars, ponderosa pine,

Fig. 12.—Black walnut plantation in Lincoln county. These trees, which are 42 year old, are from 40 to 50 feet high and attain diameters up to 12 and 14 inches.

hackberry, Chinese elm, green ash, American elm, honey locust, and bur oak will withstand the soil and climatic conditions and survive on any land being used successfully for farming throughout the state. The six species listed under tall and short shrubs are likewise adapted to these conditions with the exception of wild plum, which has not proved entirely successful in Zones 4 and 5.

The five less hardy broadleaf trees, including native cottonwood, boxelder, white willow, soft maple and black walnut, are not adapted to planting on upland conditions as prevail throughout most of South Dakota and should be planted only in the zones receiving adequate precipitation or on areas having a high water table. The dry conditions prevailing in Zones 4 and 5 preclude the general planting of the Black Hills and blue spruce.

Zone 1 covers the portion of the state in the extreme southeastern corner which receives 24 inches or more of precipitation annually and includes the following counties: Union, Clay, Lincoln, Minnehaha, Turner and Yankton, and portions of McCook, Bon Homme, and Hutchinson. Except in the driest years annual precipitation is sufficient to place water in storage in the subsoil, and trees grow well on both light and heavy types of soil. The ground water table level averages 38 feet below the surface.

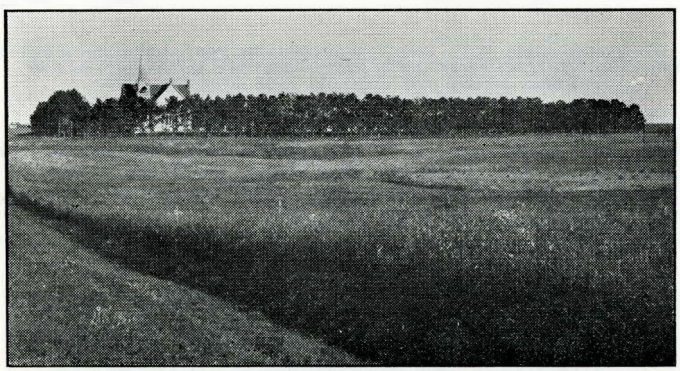

Fig. 13.—A ponderosa pine plantation around a church near Sinai, South Dakota.

The climatic conditions on the whole are the most favorable in the state. This is well demonstrated by the growth and long life under upland conditions of the less hardy species such as native cottonwood, boxelder, white willow, soft maple and black walnut.

This was the first corner of the state settled and consequently the tree plantations are slightly older than in the other zones. The average age is 35 years. The plantations in Zone 1 average 2.52 acres in size.

Zone 2 includes about one-fourth of the state at the eastern end and lies within the region receiving 20 to 24 inches of precipitation. A small portion extends west of the Missouri river in Gregory and Tripp counties. The water table level averages 31 feet. A large variety of soils varying from sand to the fine textured group are found in this zone. All recommended trees do well on sand and sandy loam groups due to the ability

of these soils to absorb the moisture which falls. Trees on fine textured soils in this zone show a decidedly higher mortality and the vigor, size, and length of life of the trees are reduced. The characteristic claypans and dense clay subsoils are found frequently. Soft maple and black walnut are not recommended for this zone and boxelder and white willow will grow well only on the sand and sandy loam soils. Plantations have an average age of 33 years and size of 2 acres.

Zone 3 includes the Glacial Dakota Lake area which extends over a large part of Brown and Spink counties. This zone is favored with slightly higher precipitation than the adjacent surrounding territory, varying from 20 to 24 inches. Soils vary from deep friable silt loams to sands and are characterized by having a water table level close to the ground surface, varying from 10 to 30 feet over large areas.

Favorable soil conditions and the high water-table level combine to make this zone one of the most successful for tree planting. All species are recommended. Plantations have an average age of 35 years and size of 3.1 acres.

Zone 4 lies roughly in the belt of 17 to 20 inch rainfall and includes the remaining part of the state which lies east of the Missouri river. The soils are ordinarily fine textured or heavy. One large area of sandy soil with a high water-table level, known as Blue Blanket Valley, occurs in central Campbell and northern Walworth counties. Extending southward through Potter and Sully counties there is also an area of loess (wind blown) soil where tree growth is markedly superior to that in most of the rest of Zone 4. Even cottonwoods on upland silt loam soils with the water

Fig. 14.—Thirty-one year old ponderosa pine trees near Sinai, South Dakota. These trees branch low to the ground and form an impenetrable shelter. Heights of 35 feet and diameter from 6 to 10 inches are attained. The soil is silt loam with a very dry fine clay subsoil. Rainfall is approximately 22 inches.

table far beyond reach of tree roots have come through the recent prolonged drought with reasonably good survival. Recommendations for planting in these special areas are the same as for Zone 3. In general Zone 4 presents difficult problems in tree planting due to the character of the soil and light rainfall. A difference of 2 inches of rainfall in this zone means

more to the success or failure of trees than 5 inches in the zones to the east which have greater rainfall. The water-table level is generally out of reach of tree roots and penetration of precipitation is generally less than two to three feet except on sandy soils. With the exceptions as noted above only the trees that are hardy throughout the state are recommended. Plantations have an average age and size of 24 years and 1.95 acres respectively.

Zone 5 includes all of the state west of the Missouri river with the exception of the Black Hills proper and immediately adjacent areas, and all of Gregory and part of Tripp county. This zone includes more than half the area of the state, but it contains less than five per cent of the tree plantations.

The soils in most of this zone are derived from shales and are fine textured or heavy. Those occurring in the northwestern part are derived from both sandstones and shales and are largely very fine sands with local occurrence of clays and gumbo. A few areas of sandy loam soils occur along the Cheyenne river. The larger part of this zone receives from 14 to 17 inches of rainfall; however, a small section in the southeastern corner receives slightly larger amounts. Water-table levels are generally out of reach of tree roots. Only the species which are hardy throughout the state are recommended for this zone. Plantations have an average age of 17 years and average 1.3 acres in size.

Fig. 15.—Successful plantation of green ash in Corson county. The site is very difficult for tree growth because of low rainfall and the fine textured soil; however, by practising clean cultivation the entire plantation has suffered very little ill effects of dry weather.

The work in South Dakota of the Northern Great Plains Field Station at Mandan, North Dakota, has been largely in this zone. The good condition of many of these plantations is due to the careful methods of establishment and cultivation under the direction of this station.

Zone 6 includes a small area adjacent to the Black Hills on the north and east. Much of the zone is irrigated and the precipitation is in excess

of Zone 5, due to the influence of the adjacent mountains. The water-table averages 20 feet below the surface of the ground. Growing conditions for trees are quite favorable under irrigation and all listed species are recommended excepting soft maple and black walnut. The average age and size of the plantations is 24 years and 0.82 acres respectively.

Planting Plan

Location

The prevailing winds in South Dakota are from the northwest during the winter months and generally from the south and southeast during the summer. Some of the most damaging hot winds come from the southwest. Farmstead and school shelters are planted chiefly for winter protection

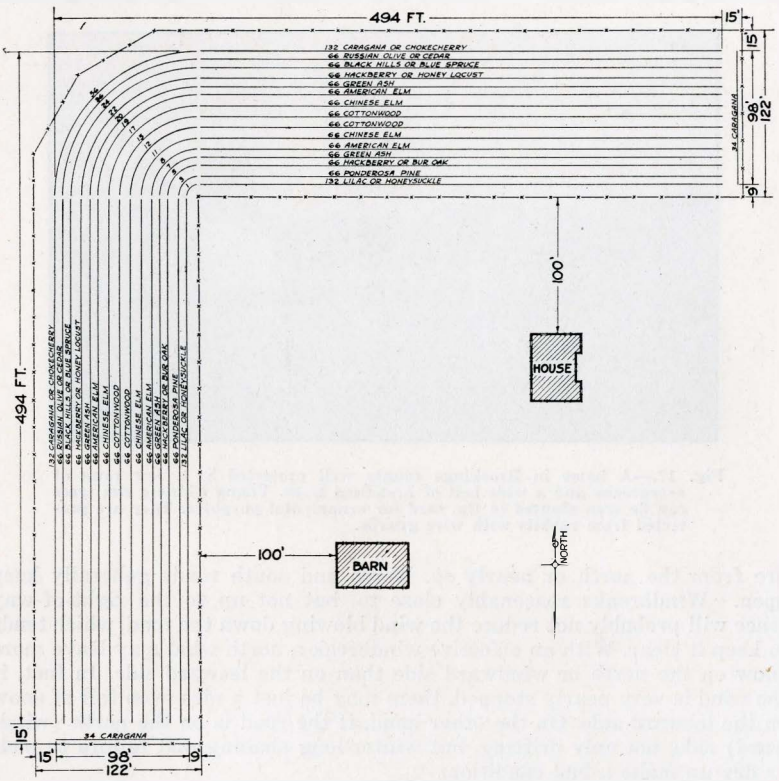

Fig. 16.—Plan of a farmstead shelter and its relation to the farm buildings. Important features: (1) Width 100 feet or more. (2) Distance from buildings 100 feet. (3) A fence to exclude livestock.

and are placed on the north and west sides of the farm buildings. Windbreaks are placed on the south and west sides of fields for the protection of crops. Orchards need protection during both summer and winter, and trees should be planted on the west, north and south.

Where buildings are located in such a manner as to prevent planting on two sides, protection may be obtained by planting on either the north or west side, and making the shelter a little longer to the north or west than would otherwise be necessary. Trees on the south side will temper the effect of hot summer winds. Fig. 16 presents a recommended plan for a farmstead shelter and its relation to the farm buildings. The best protection is obtained by planting the inside row of trees not more than 200 feet or less than 100 feet from the house and barn. A row of low shrubs planted across each end of the plantation will check the wind from sweeping into end zones and provide shade from the side to prevent soil drying and the encroachment of weeds.

Field windbreaks are planted on the south and west sides of cultivated fields for the protection of crops. Care is necessary in their location to prevent snow drifting on highways. In South Dakota the drifting winds

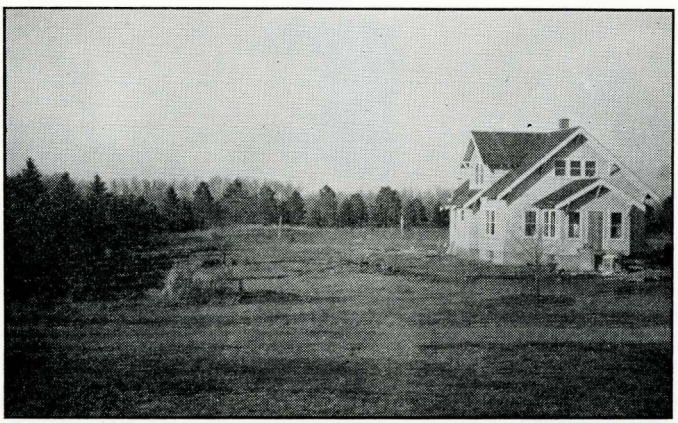

Fig. 17.—A home in Brookings county well protected by a few rows of evergreens and a wide belt of broadleaf trees. Young Chinese elm trees can be seen planted in the yard for ornamental purposes. They are protected from rabbits with wire guards.

are from the north or nearly so. North and south roads generally keep open. Windbreaks reasonably close to, but not up to the right-of-way fence will probably not reduce the wind blowing down the road, which tends to keep it clear. With an effective windbreak a north wind may leave more snow on the north or windward side than on the leeward side. In fact, if the wind is very nearly stopped, there may be just a nice even fall of snow on the leeward side. On the other hand, if the road is on the north (windward) side, not only drifting, but winter-long shading and failure to melt or dry up make a bad condition.

General recommendations for planting trees adjacent to highways are as follows: Do not plant windbreaks within two rods of fences bordering north and south highways; an open windbreak of only a few rows of trees should never be planted within five rods of the right-of-way fence, either on the north or the south side of the highway; a dense or wide windbreak on the north may safely come close to the road, but on the south should never be closer than five rods.

Size of Plantations

A plantation for a farmstead shelter should include from 1 to 3 acres. It should not be less than 100 feet in width and should be long enough to protect the buildings and feed lot. This width effectively stops the wind. It is wide enough to prevent snow from drifting through into the yard or around buildings and to create the best growing conditions for the formation of a leaf mulch beneath the trees. A snow trap formed by leaving an unplanted strip between the two outside rows and the remainder of the plantation is desirable in connection with farmstead shelters which are less than 100 feet wide. This will prevent snow from blowing through into the

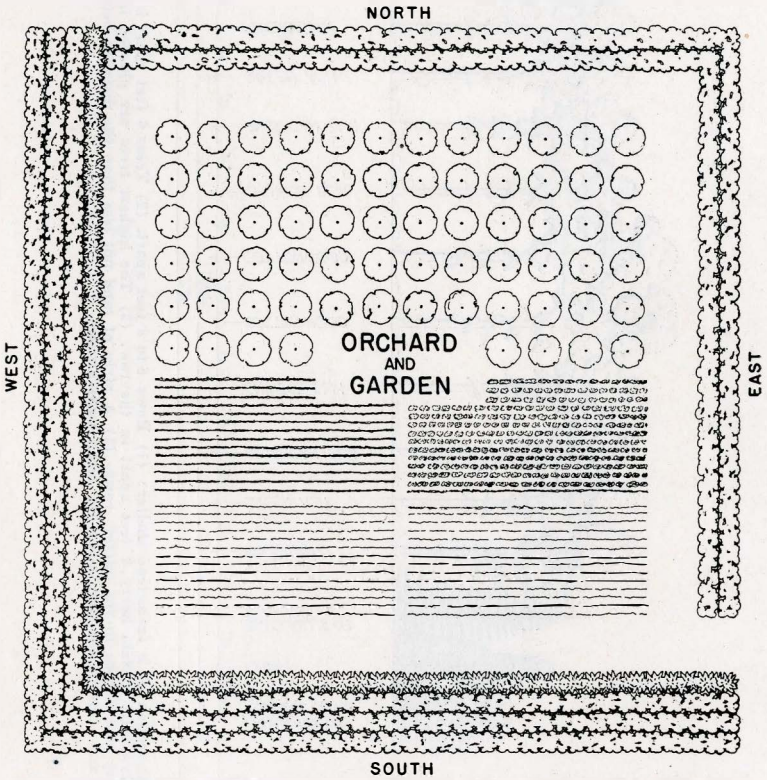

Fig. 18.—Plan for orchard and garden protection. The greatest protection is needed on the south and west. Leave at least 20 feet between trees and orchard or garden. Provide for air drainage at the lowest point by omitting a section of trees or by pruning the branches up several feet from the ground.

yard and around buildings. Generally, snow traps are not desirable when their use can be avoided. They form a strip of ground which grows up to weeds or grass unless cultivated frequently and the snowdrifts which are an important source of moisture are trapped in the open instead of beneath the trees. The open area of the snow traps forms an excellent place for gardens.

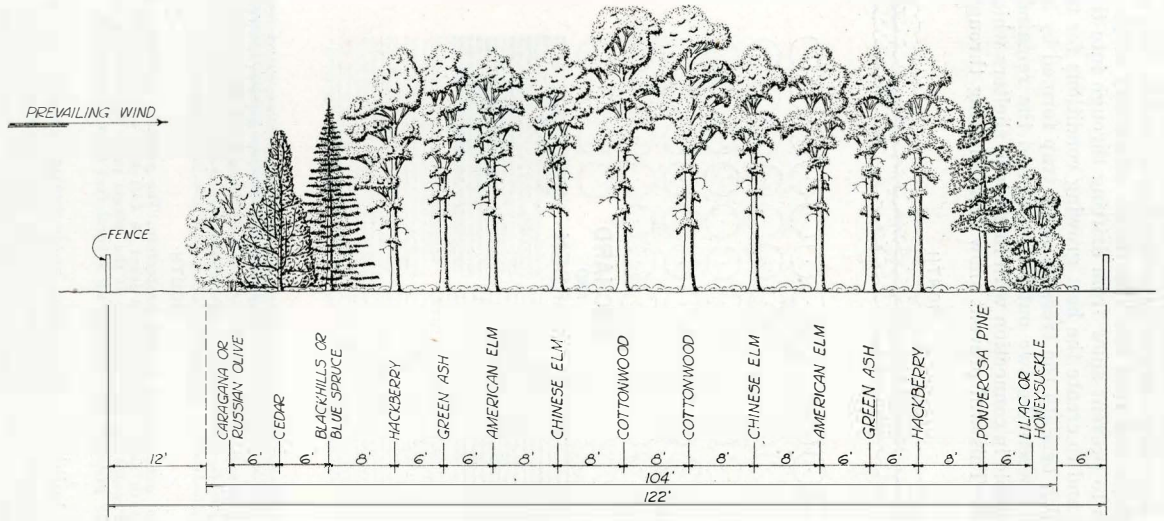

Fig. 19.—Cross-section of a farmstead shelter: (1) Rows 6 to 8 feet apart. (2) Trees 6 feet apart in the row. Caragana, lilac, honeysuckle, buffalo berry 3 feet apart in the row. (3) The highest trees are planted in the center and the lowest trees and shrubs in the outside rows. (4) A strip of land not less than the distance between rows is left on each side and ends of the plantation for clean cultivattion.

Fig. 20.—An effective farmstead shelter with a dense row of low evergreen trees on the outside.

Fig. 18 presents a recommended plan for orchard and garden protection. Air drainage should be provided at the lowest point by omitting a section of trees or by pruning the branches up several feet from the ground. This permits free movement of the air and lessens the possibility of frosts.

The most effective or nearly optimum width for a field windbreak is about 100 feet. The standard width of field windbreaks recommended by the United States Forest Service is 10 rods. This consists of 8 rods of trees and 1 rod of fallow ground on each side. A quarter of a mile is the minimum length which should be planted.

When single rows of trees or narrow strips can be kept alive interplanting them between the main shelterbelt strips is very desirable.

Width is desirable when there may be rather severe exposure and drought.

Spacing

Close spacing has in most instances resulted in better shelters than wide spacing. Wind protection is obtained at a much earlier date. Branches grow together in much shorter time and weeds and grass are excluded. A leaf mulch is formed beneath the trees which readily absorbs and retains moisture. Snow melts more slowly and there is less evaporation from the ground surface.

A spacing distance of 6 to 8 feet between rows is recommended for the state in general and the trees should be planted 6 feet apart in the rows. Fig. 19 shows a cross-section of a farmstead shelter. The tallest trees are planted in the center and the trees progressively decrease in height from the center to the outside. Low bushy shrubs and trees are used for the outside rows. Because of the rapid growth of cottonwood and Chinese elm these species are planted in rows 8 feet apart. Where evergreens are planted next to broadleaf species a distance of 8 to 12 feet between rows is recommended to prevent top injury and shading of the evergreens by the more rapid growing broadleaf trees.

Fig. 21.—Close spaced trees shade the ground at an early date, preventing the growth of weeds and grass and eliminating the necessity for cultivation.

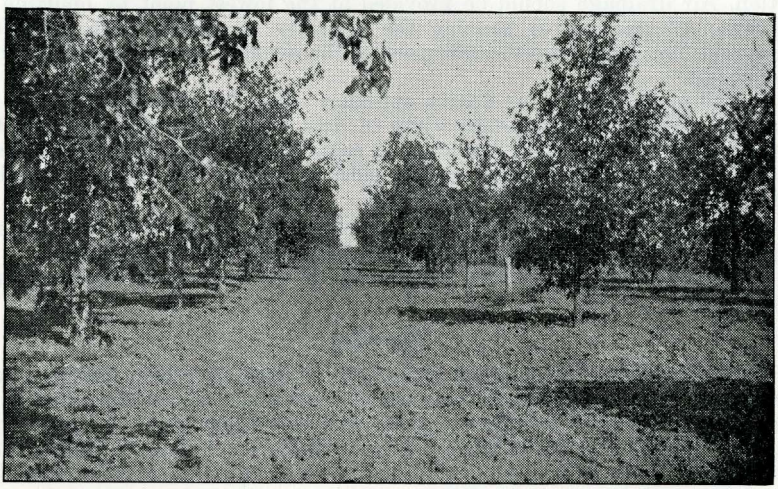

Fig. 22.—Well cultivated American elm plantation growing on fine textured soil and under low rainfall conditions. McLaughlin, South Dakota.

Under dry conditions such as prevail in much of the western half of the state, wider spacing with clean cultivation may be practiced to conserve the limited amount of moisture. Rows should not be farther than 12 feet apart. The advantages of wider spacing, however, do not warrant its general use. A smaller amount of snow is trapped by wider spacing. This melts and runs off more quickly, the ground is more exposed to evaporation by wind and the formation of a desirable leaf mulch is retard-

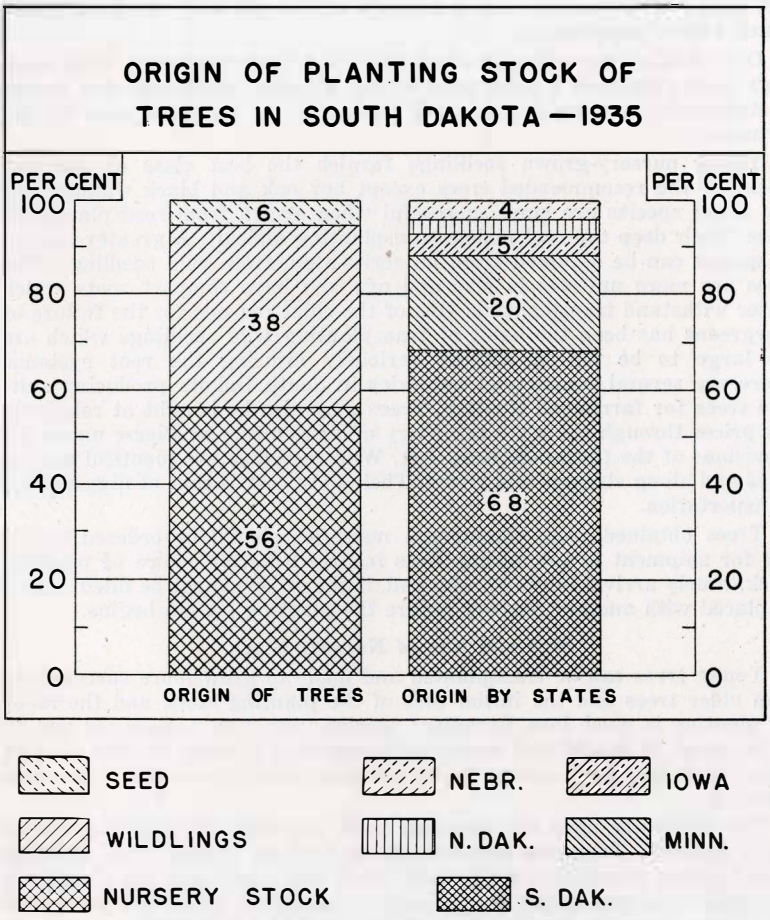

Fig. 23.—Class of planting stock and geographic sources. Success can be expected only when planting stock is from hardy northern grown trees. Select seed from trees grown in South Dakota or from plains regions having a colder climate.

ed or entirely prevented. There is no assurance that plantations having wide-spaced rows will be cultivated regularly. Ordinarily trees are well taken care of for two or three years; thereafter, however, it is the exception rather than the rule if trees are cultivated.

Planting Stock

Source

Fig. 23 shows the origin of planting stock of the present tree plantations in South Dakota. Trees taken from states having a milder climate than South Dakota or in some instances from one part of the state to another will not succeed because of the more rigorous climatic conditions. This lack of hardiness may not be apparent for a number of years, which

fact makes it important that the origin of the planting stock be determined before planting.

Over half of our planting stock has come from nurseries. Wild seedlings have furnished a large part of the planting stock and this source is still used extensively. A small portion is grown from seed by the farmers.

Young nursery-grown seedlings furnish the best class of planting stock for the recommended trees except bur oak and black walnut. The two latter species are more successful when grown from seed planted in place. Their deep tap root makes transplanting difficult. A greater variety of species can be obtained from nurseries than from wild seedlings. The trees are more uniform in size and age and have compact roots which better withstand transplanting. One of the chief reasons for the failure of evergreens has been the habit of transplanting wild seedlings which are too large to be moved without seriously injuring the root systems. There are several commercial nurseries in South Dakota producing suitable trees for farmstead shelters. Trees may also be bought at relatively low prices through the state Secretary of Agriculture at Pierre under the provisions of the Clarke-McNary Act. Wild seedlings are plentiful around lakes and along streams and rivers. Their only cost is that of digging and transportation.

Trees obtained from commercial nurseries should be ordered in the fall for shipment in the spring. This insures a better choice of planting stock, timely arrival in the spring, and, if the order cannot be filled it may be placed with another nursery before the planting season begins.

Size and Age of Nursery Stock

Young trees can be transplanted and made to grow more successfully than older trees and the initial cost of the planting stock and the labor for planting is much less. Broadleaf species from 1 to 2 years old and 12 to 24 inches in height and evergreens from 2 to 6 years old and 6 to 12 inches in height have proved to be the most satisfactory sizes for farm planting.

The following ages for planting stock are recommended for use in South Dakota: Tartarian honeysuckle and white willow from cuttings rooted 1 year in nursery; cottonwood from wild seedlings; the remaining broadleaf trees and shrubs, 1 or 2 year old seedlings; cedar and ponderosa pine transplants 2 to 4 years old, and spruce, 4 to 6 years old.

Establishing the Plantation

Ground Preparation

Land to be planted with trees should be left idle and summer fallowed the year before. This permits the maximum absorption of moisture from rain and snow, destroys weed growth, lessens evaporation and prevents crusting and packing after rains. Crop land should be fallowed one year and sod land two years before planting.

Not later than the 1st of June, plow the land to a depth of 6 to 8 inches; then harrow it once or twice. During the summer, cultivate the land as often as necessary to free it from weeds and grass and to keep the surface from packing and crusting after heavy rains. The duck-foot

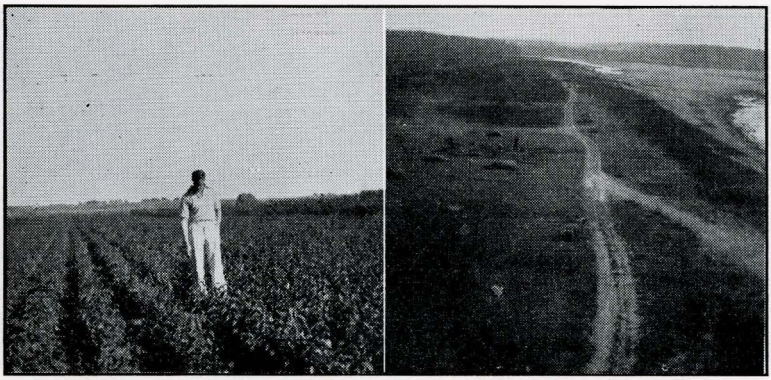

Fig. 24. Left.—One-year-old American elm seedlings growing in nursery at Rapid City, South Dakota. Right.—Wild broadleaf seedlings growing along the Missouri river near Pierre, South Dakota. Much of our planting stock is obtained from similar sources throughout the state.

type of cultivator is the most satisfactory for leaving the ground in a rough and ridged condition. The land should not be plowed in the spring of planting, for a firm, well settled soil provides the best planting site.

If trees are to be planted in soils subject to blowing, plow the land the previous summer and have it ridged in the fall with a lister or cultivator. Plant the trees the following spring without further cultivation.

The diversion of surface runoff to the planted area by means of plowed furrows will insure greater success to both young and old plantations. Where possible, create small lakes or ponds above or adjacent to plantations to hold surface runoff. It is not necessary that these ponds contain

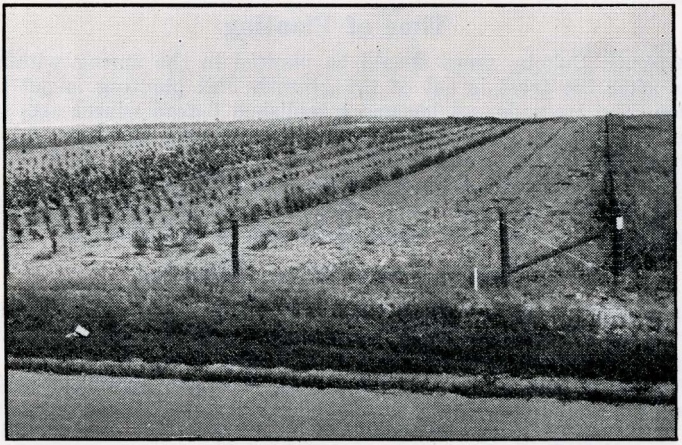

Fig. 25.—One-year-old field windbreak protected by a well constructed fence to exclude all classes of livestock.—Picture courtesy of Plains Shelterbelt Project.

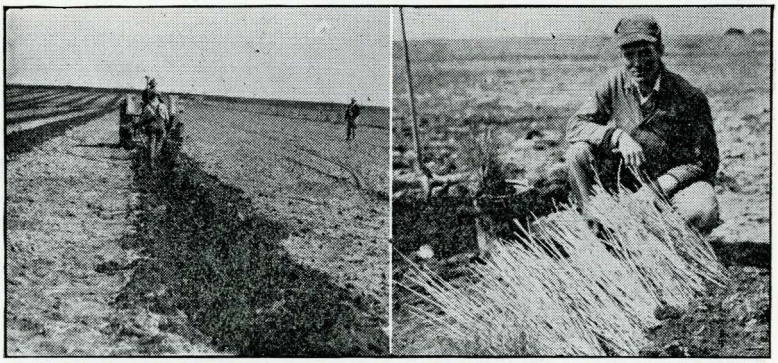

Fig. 26. Left.—Laying out rows of a tree plantation by plowing furrows. Note the well prepared ground, free from weeds and grass and presenting a firm, compact soil for planting. Right.—Broadleaf tree seedlings heeled-in in field at a planting site. A few trees at a time are removed from the heeling-in trench for planting. They are immediately placed in a bucket which contains wet moss, burlap, water or thin mud to protect the roots from the drying effect of the air.—Pictures courtesy of Plains Shelterbelt Project of the United States Forest Service.

water all summer. Water caught, if lasting only for a week or two, will add much moisture to the subsoil in the immediate vicinity.

Fencing

The exclusion of all forms of livestock is necessary for the successful establishment of trees. A substantial fence, preferably woven wire, should be constructed prior to or immediately after the trees are planted.

Our state survey figures disclose that 61 per cent of the trees in ungrazed plantations are living while only 47 per cent are living on plantations in which livestock has been allowed to graze.

Time of Planting

In South Dakota, trees should be planted in the spring within four weeks after the frost is out of the ground. Fall planting is not recommended. The trees do not become established before winter sets in and by spring they have been weakened because of loss of moisture and exposure to the rigors of winter weather.

Rather than plant a shipment of trees received in the fall, it is better to store them in the soil until spring in a place where they will be protected from the sun and wind and covered by whatever snow falls.

Storing Trees Before Planting

Trees from a nursery can be kept for a few days before planting by unwrapping and wetting down the roots and packing material, repacking and storing in a cool, protected place in a barn or cellar.

If planting will not start within a week the trees should be heeled-in. To heel-in, dig or plow a trench about one foot deep, extending east and west and sloping on the south side. Unpack the trees and spread them along the sloping side of the trench in small enough bundles so that earth can be thoroughly packed around and between the roots and the lower half of the stems. Wet the roots well, fill in the trench until the tops are about

one-half covered; then soak the soil with water if dry. Fig. 26 illustrates the method of heeling-in trees for temporary storage. Select a cool shady place for this purpose.

Fig. 27. Left.—Five-man planting crew. Trees are planted in plowed furrows. The long handled spade has proven the best planting tool. Trees are planted in a check-row pattern to permit cross cultivation. Right.—Trees are carried to the field in buckets containing a small amount of water or thin mud. The roots are kept moist by wrapping in wet burlap. Pictures courtesy Plains Shelterbelt Project.

Planting the Trees

Trees should be planted immediately upon receiving them from the nursery or as soon thereafter as weather conditions permit. Planting should be completed before the buds open. If possible, set out the trees on a calm, cloudy day to prevent the roots from drying.

After the size and location of the plantation is determined, it should be laid out on the ground as outlined under "Planting Plan," in this circular. The rows should be plainly marked by plowing furrows or using a string or binder twine. Fig. 26 illustrates the marking of the rows by plowing a furrow.

Trees should be set out so that they are in straight rows running in cardinal directions. This permits cross cultivation. Fig. 27 illustrates field methods used by the Plains Shelterbelt project of the Forest Service in South Dakota.

The trees are planted in the bottom of the furrows and the furrow deepened where necessary. Subsequent cultivation fills in the furrows.

Where trees are to be on two adjacent sides of the farm buildings, a round corner is desirable in the plantation as it requires only one-half the

number of turns necessary in cultivating with a square corner. The position of the rows of trees on the round corner can be readily determined. Tie a long piece of twine to the inside corner fencepost and extend it west to the outside tree row marked on the ground by the furrow or stake. Swing in a quarter-circle to the north and east and at the same time draw a line on the ground with a stake to mark the row. Mark the remaining rows in the same manner. Trees in the rows on the curves are planted six feet apart without regard to the position of the trees in the adjacent rows.

A strip of ground as shown in Fig. 28 should be left around the outside edge of plantations to be regularly cultivated and kept free from plant growth. This practice has been found to help greatly in stopping the encroachment of weeds and grass into the outer edges of the plantation and to assist in collecting and storing soil moisture.

In planting trees the roots should be kept moist at all times. Carry them wrapped in burlap or moss in a bucket containing a small amount of water or thin mud. Dig the hole large enough to permit the roots to

Fig. 28.—Clean cultivated strip around the edge of a spruce plantation. Weeds and grass are prevented from encroaching upon the edges of the plantation and soil moisture is conserved. Most farms in the state could support a magnificent stand of trees as shown here provided proper cultivation were given and grazing animals excluded. Picture courtesy of Northern Great Plains Field Station, Bureau of Plant Industry, Mandan, North Dakota.

be spread out freely. Set broadleaf trees in the hole a few inches deeper than their position in the nursery. Set the trees in the center of the holes by spreading out the roots to their full length and filling in from all sides with fine loose dirt. Tamp the earth securely around the trees as the hole is being filled.

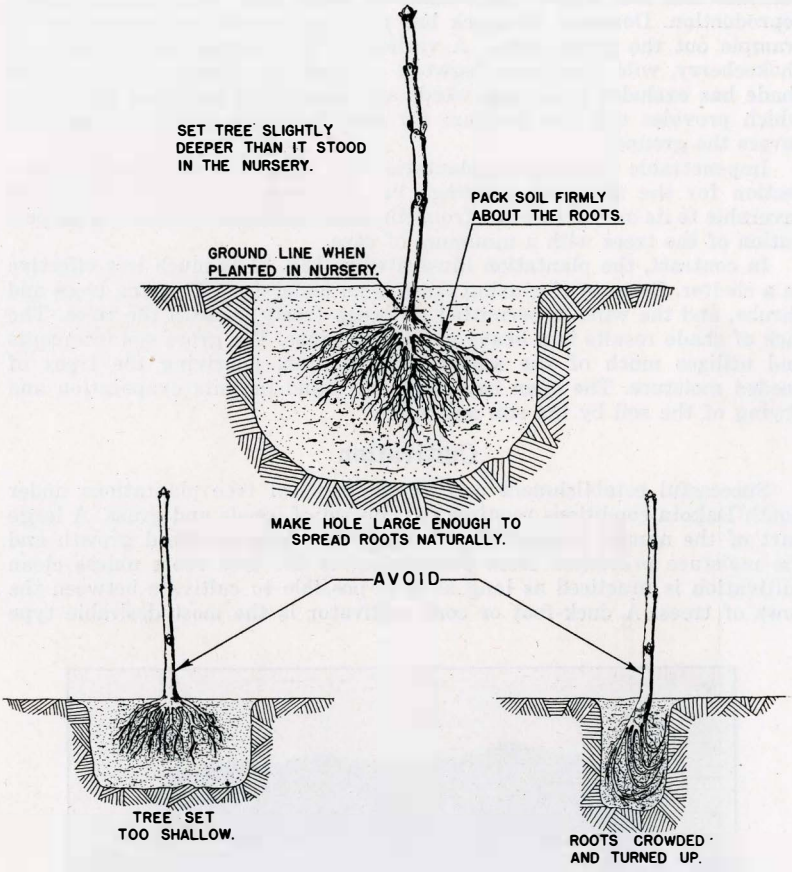

Fig. 29.—Correct and incorrect planting methods, adapted from Fig. 5 of Farmers Bulletin No. 1603, "Planting and Care of Shelterbelts on the Northern Great Plains."

Refer to Fig. 29 for correct and incorrect planting methods.

Care and Protection of Plantations

Fig. 30 shows an old plantation which illustrates the beneficial effect of proper management. Fencing has excluded livestock completely. The old cottonwood trees have a dense understory of young ash, hackberry, boxelder and soft maple trees, many of which have come in by natural reproduction. Domestic livestock has not been present to browse and to trample out the young trees. A variety of low shrubs such as currant, chokecherry, wild plum and dogwood complete the plant cover. A dense shade has excluded grass and weeds and about four inches of leaf mold, which provides the best medium for absorbing and retaining moisture, covers the ground.

Impenetrable to wind, the plantation not only furnishes complete protection for the sheltered buildings but it creates conditions which are favorable to its own protection from climatic conditions and for the perpetuation of the trees with a minimum of care.

In contrast, the plantation illustrated in Fig. 31 is much less effective as a shelter. Because of grazing there is no understory of young trees and shrubs, and the wind is permitted to sweep freely beneath the trees. The lack of shade results in a heavy growth of grass. The grass sod intercepts and utilizes much of the annual precipitation, depriving the trees of needed moisture. The open nature of the stand permits evaporation and drying of the soil by the sun and wind.

Cultivation

Successful establishment and development of tree plantations under South Dakota conditions requires the control of weeds and grass. A large part of the annual precipitation is dissipated through weed growth and the moisture prevented from penetrating to the tree roots unless clean cultivation is practiced as long as it is possible to cultivate between the rows of trees. A duck-foot or corn cultivator is the most desirable type

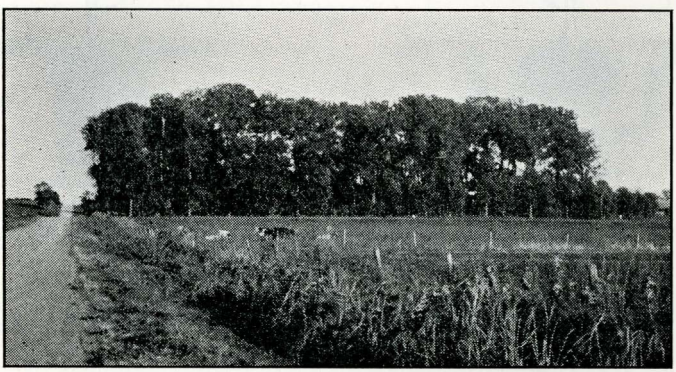

Fig. 30.—Well managed plantation. Grazing was excluded permitting an understory of young trees and shrubs to come in and the formation of about four inches of leaf mold on the ground which readily absorbs and retains moisture. Complete wind protection is provided.

Fig. 31.—Poorly managed plantation. Wind protection is slight when compared to Fig. 30. Grazing has prevented the growth of an understory of young trees and shrubs. The invasion of grass and lack of cultivation prevents natural reproduction which will finally result in the disappearance of the plantation.

of implement. Trees planted in rows 6 to 8 feet apart will grow together in about 5 years and further cultivation is unnecessary, except for the clean strip around the outside edge of the plantation.

Mulching with straw or manure has not proved a successful substitute for cultivation. The plowing under of manure on heavy soils is a good practice. Mulching ordinarily results in several undesirable features. Trees develop shallow roots, many of which are between the mulch and the ground surface. Fewer tap roots are formed and the trees suffer heavy losses during drought periods. Mice are harbored beneath the straw and feed on and girdle the roots near the ground surface. Weed and grass seed are introduced and the danger of fire is increased. Light rains are prevented from reaching the soil.

Pruning

Tree plantations made for wind protection require very little pruning. Trees selected for the three outside rows should have the habit of branching freely from the ground up and the branches should never be pruned. The taller trees on the inside of the plantation should be encouraged to develop a main central trunk. This can best be done by continuous observation and careful pruning a foot or two from the ground while the trees are young.

The practice of trimming the lower branches of trees up to 5 or 6 feet is very objectionable because it permits wind to sweep beneath the trees, lessens the effect of the plantation for wind protection, causes excessive drying of the soil and prevents the formation of snow drifts during the winter and the retention of moisture which falls during the summer.

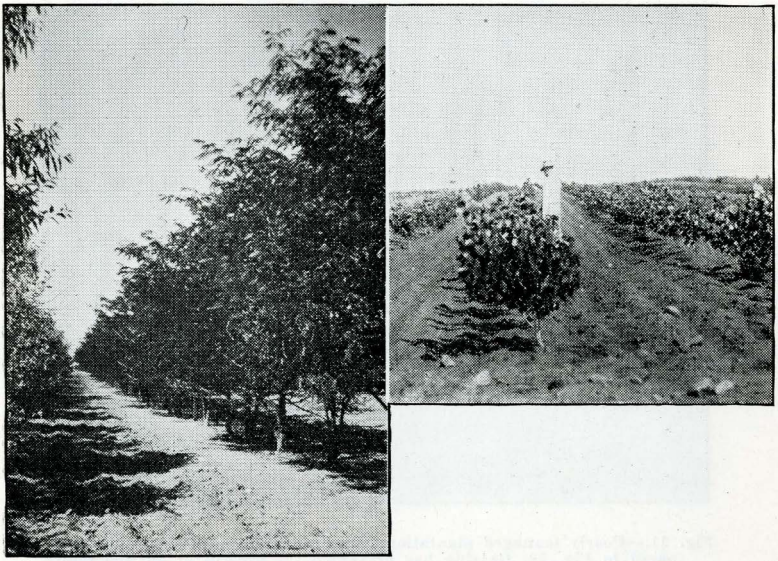

Fig. 32. Left.—Trees planted in wide-spaced rows require several cultivations each year to keep down weeds and grass and to conserve the soil moisture. The expense and time involved in maintaining the proper ground conditions with wide spacing is finally much greater than with close spacing and the latter is more effective as a shelter. Right.—Clean cultivation is necessary in all parts of the state for successful establishment of young trees. With close spacing the tops of the trees grow together in about 5 years and eliminate the necessity of further cultivation. Pictures courtesy Plains Shelterbelt Project.

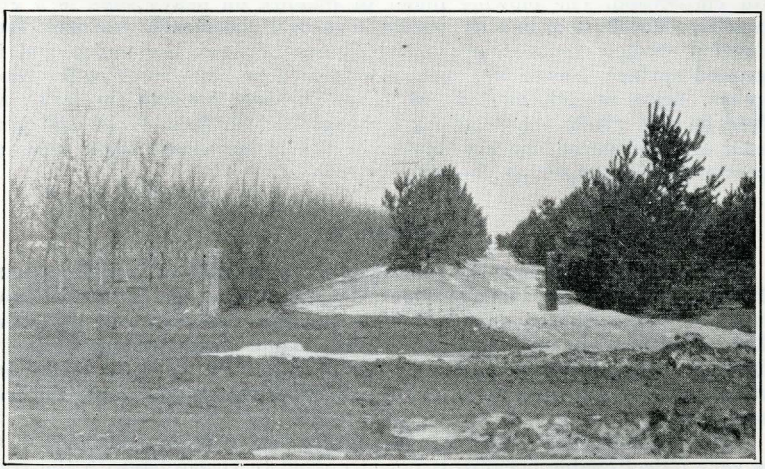

Fig. 33.—A portion of a plantation at a Federal field station at Ardmore, South Dakota. The row of Caragana on the left effectively checked the wind, causing the formation of a snow bank on the leeward side. Picture courtesy Extension Service, University of Wyoming.

Fig. 33 shows a plantation at a government field station at Ardmore, South Dakota. A few rows of green ash and American elm trees on the windward side were pruned up about four feet. The picture indicatees how the snow blows through these trees but is stopped by a dense row of caragana, forming a heavy snowbank the moisture from which is very beneficial to the evergreen trees at the right.

Dying top branches are ordinarily suffering from lack of moisture. Plantations throughout a large part of the state are affected by this condition due to the drought the past few years. In some instances only a few of the top limbs are dead, while in other cases all the top branches are dead and new growth has started among the lower branches. This is particularly true of the plantations on the upland ridges and slopes. Many of our broadleaf trees respond very readily to trimming and will produce a very satisfactory new top.

Figures 34 and 35 (left) illustrate successful trimming of boxelder and cottonwood trees. Branches should be sawed off just below the line of dead wood. Make the cut on a slant downward away from the trunk to permit water to drain away and lessen chances of decay. Where possible, face the cut away from the direct rays of the sun to avoid checking of the wound. Cover all cuts with creosote or paint.

The closer to the trunk the dead side branches are cut off the sooner they will heal. Do not leave a stub sticking out but saw off as close to the trunk as possible without injuring the bark. Large heavy branches should first be undercut to avoid splitting of the limbs and ripping of the bark.

A sharp saw is the safest tool for trimming and pruning. An axe should not be used unless in the hands of an expert and even then it is difficult to avoid leaving short stubs or injuring the bark.

An old plantation properly cleaned out and trimmed presents a very pleasing appearance and adds materially to the value of any farm. Dead

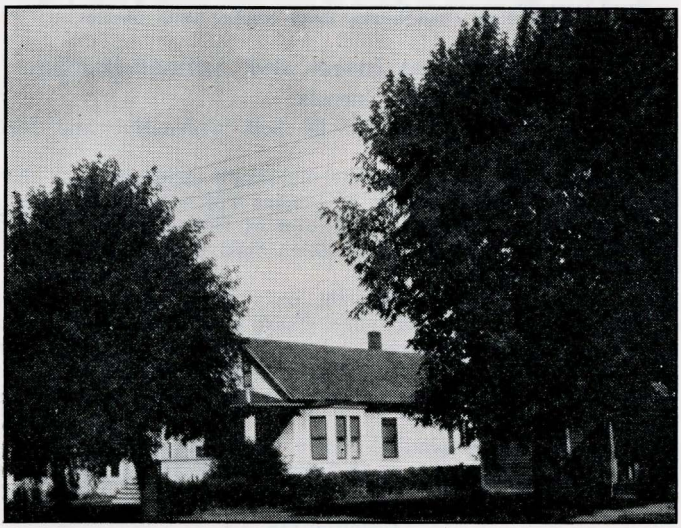

Fig. 34.—Boxelder trees produce a satisfactory new top after trimming.

trees should be cut down flush with the ground to avoid unsightly stumps. The smaller stumps may be pulled up with a tractor and log chain or cable.

The best time to prune and trim trees is in the early spring. Growth will start soon and the wounds will heal over more quickly.

Many of the broadleaf trees sprout readily from stumps. Trees which have died back to the ground and have been cut down will produce a number of sprouts. Keep all but one sprout on each stump cut back for a few years and the dead trees will be quickly replaced with vigorous growing sprouts that will afford wind protection in the shortest possible time. Fig. 35 (right) illustrates a dense windbreak of green ash grown from sprouts.

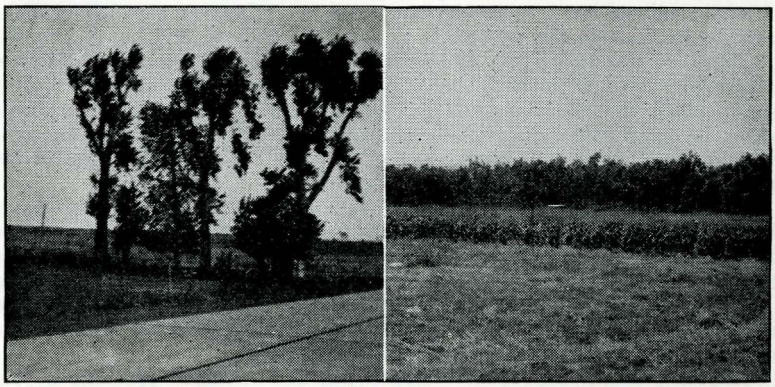

Fig. 35. Left.—Cottonwood trees after trimming. Right.—Green ash windbreak produced from the sprouts of stumps of trees which had died down to the ground. Near Chamberlain, Brule county, South Dakota.

Protection Against Insect and Animal Damage

Insects

Insect damage can be lessened by both preventive and corrective measures.

Close spacing which produces the maximum shade beneath the trees, keeps out insects. Plant sparingly of species which are severely attacked. Exclusion of grazing and the prevention of fires increase the vigor of the trees. Encouragement of birds which feed upon the insects is very beneficial.

Regular inspection and treatment or removal of infested trees is necessary. Instances have been found where borers have been introduced into a plantation by hauling posts and wood from an old dying plantation to a stand of healthy trees. Dead material should be piled as far away from the plantation as possible and it is desirable to remove the infested stumps.

Insects which attack planted shade and windbreak trees in South Dakota may be classified as wood borers, tip feeders, leaf-eaters, and leaf-suckers.

Wood-borers

Borers usually establish themselves first in the unhealthy or weakened

tissue found adjacent to wounds. Any condition such as drought or defoliation which tends to lower the vitality of the trees is favorable to the development of this group of insects. In an attempt to control the ravages of wood-borers, several measures may be taken. Where infestations are heavy the badly attacked trees should be removed and burned. If the wood is to be used for fuel do not pile adjacent to the trees. In trees less severely attacked, the borers may be killed by inserting in the tunnels carbon bisulfide or a mixture of propylene dichloride and carbon tetrachloride (sometimes known as Dowfume).

This mixture can be applied with an oil can and should be used during warm weather and before the adults emerge in June. The holes then should be sealed with wax or mud in order that the poisonous fumes may penetrate the full length of the cavity and remain long enough to kill the grubs. Carbon bisulfide is inflammable and explosive and should be kept away from fire or sparks.

Carpenter Worm (*Prionxystus robinae Peck*). The carpenter worm is the most widely distributed and most destructive of the tree borers. This insect has been found attacking green ash, Russian olive, honey locust, black walnut, black locust, poplar, cottonwood, willow, elm, soft maple, pear, cherry and lilac. A severe infestation often results in a complete honeycomb of tunnels, causing wind breakage, lower wood value, and death to the trees. If trees survive an attack by borers they usually become stunted.

The larvae enter the trunk and feed at first on the tender green cambium and sapwood and later bore into the heartwood. They become two to three inches in length and are greenish white in color. The borers' work may be recognized during this stage by the appearance on the bark and at the base of the tree of chewed bits of wood known as frass.

Ash tree borer (*Podosesia fraxini Lugger*). The ash tree borer is similar in habits to the carpenter worm but confines its activities more to the green ash and lilac.

Poplar borer (*Saperda calcarata Say*). The poplar borer seldom causes the death of trees. However, these borers are often followed by other injurious insects and diseases which sometimes kill the trees. At maturity the grubs are two inches in length, thick and yellowish white in color. External evidence of the borers' work can be seen in blackened swollen scars on the trunks. Around the base of an infested tree may be seen piles of wood shavings and frass pushed out of the holes by the borers.

Elm borer (*Saperda tridentata Oliv.*). A heavy infestation of this insect will kill the trees. In its injurious stage, it is a flattened, white, footless grub. External evidence of the presence of this insect can be seen in thinning foliage, dying limbs, dark sawdust collected in the crevices on the trunk, and loose bark.

Tip Feeders

This class of insects attack the tips of branches by boring into the wood and forming galleries, resulting in the death of the parts attacked.

Pine tip moth (*Rhyacionia frustrana bushnelli Comst.*). The pine tip moth is found attacking planted ponderosa pine trees. In the destructive stage it is a reddish brown larva with a dark head and is three-fourths of an inch in length. Evidence of its work can be seen in dwarfed needles on the new shoots and by the occurrence of small tubes of pitch at the

base of the injured part. The tunneling and killing of the terminal parts results in deformed tops and side branches, but if the attack is severe it will kill the host tree. The most satisfactory control method is to cut off the infested twigs and burn them.

Leaf-eaters

Leaf eating insects are found throughout the state. They include grasshoppers, blister beetles and the striped cottonwood leaf beetle. These insects may be controlled by an arsenic spray or poison bait.

Grasshoppers (*Melanoplus spp.*). During periods of severe drought grasshoppers have done considerable damage to trees in South Dakota. This is especially true where the fields adjacent to a plantation have been eaten or dried up so that the only available green material is the leaves of the trees. Even evergreens, such as pine and spruce, have been completely defoliated.

The most effective control is secured by spreading prepared bran mash adjacent to the plantation and beneath the trees. Special care should be taken to keep this poison out of reach of children, livestock, poultry, wild game and birds. For safety, spread the bait thinly over the ground. Distribute the poison during the early part of the morning while the air temperatures are from 70 to 80 degrees F. This is during the time they are doing their first feeding of the day.

The bran formula recommended by the Bureau of Entomology of the United States Department of Agriculture is as follows:

Coarse bran	100 pounds
Crude arsenic	5 pounds
Cane molasses	1½ gallons
Water	10-12 gallons

Good results depend on mixing the mash thoroughly until it contains no lumps and is moist throughout.

Striped cottonwood leaf beetle (*Lina scripta Fabr.*). Aside from grasshoppers, the striped cottonwood leaf beetle is perhaps the most destructive tree defoliating insect in South Dakota. Both the adults and the larvae cause damage. Soon after the leaves of the cottonwood and willow appear in the spring, these beetles come out of their winter hibernation quarters and feed on the tender shoots and leaves.

This beetle is oval in shape, about one-quarter inch in length and generally yellowish with dark markings. In the caterpillar stage of this insect the grubs are three-eights of an inch in length when fully developed and have a yellowish white color. These fully grown caterpillars devour the entire leaf except for the vein and petioles.

A poison spray during the first attack in the spring and later when necessary is the most effective control measure for this insect. The following formula has been recommended by the state entomologist of South Dakota:

	50 Gallon Formula	3 Gallon Formula
Powdered lead arsenate	1 pound	2 heaping tablespoons
Laundry soap	3 pounds	3 ounces
Water	50 gallons	3 gallons

Blister beetles (*Macrobasis spp. and Epicauta spp.*). Caragana is the most common windbreak species attacked by this pest but in some portions of South Dakota defoliation of Chinese elm has been reported.

There are various species of this beetle but all have similar habits.

There are two general sizes and colors—the gray and black, three-fourths of an inch in length; and the metallic blue, 1 to 2 inches in length.

The above formula recommended for the striped cottonwood leaf beetle also is effective for control of the blister beetles.

Leaf-suckers

This class of insects suck the sap from the leaves causing them to curl and finally die. Since these insects do not eat the leaves a contact rather than a stomach poison is necessary. The potato-leaf hopper and the red spider are the most important.

Potato-leaf hopper (*Empoasca fabae Harris*). The potato-leaf hopper is a small green wedge-shaped insect about one-eighth of an inch in length. It often attacks the leaves of caragana, causing them to turn brown and curl upward. Small triangular brown spots at the tips of the leaves are the early symptoms of an infestation. Little damage is done to caragana unless it is entirely defoliated or considerable defoliation is repeated from year to year. A Bordeaux spray applied at the earliest sign of injury is an effective means of control.

Red spider (*Tetranchus telarius Linnaeus*). When the needles of spruce or other evergreens have a blotched appearance with a fine silk webbing on the under side of the branches it probably is due to a small hardly distinguishable red mite known as the red spider. If a tree is severely attacked, complete defoliation might take place. A lime-sulphur or glue spray applied during the summer is a satisfactory control measure. The glue spray should be in the proportion of ½ pound of glue to 5 gallons of water.

If you are unable to control an insect attack on your trees or desire more detailed information, communicate with the county agent, the state entomologist at Brookings, S. D., or the Bureau of Entomology, Washington, D. C.

Domestic Livestock and Rabbits

All animals should be kept out of tree plantations. Winter protection for livestock should be provided by placing them within enclosures adjacent to the plantation on the leeward side but not in the plantation itself. Horses, cattle, sheep, hogs and poultry have a detrimental effect upon the plantation. Grazing kills out young seedlings and prevents the formation of an understory of shrubs; branches are broken and the trunks injured. The formation of a leaf mold on the ground is prevented and the soil is trampled and packed to an extent which prevents the ready absorption and retention of moisture.

As indicated by the state survey, plantations with a ground cover of leaf mold have 66 per cent of their trees living; those with a cover of weeds, 51 per cent; and those covered with grass, 46 per cent.

Fig. 36 illustrates the effect of grazing upon the ground cover and soil. On the left side of the picture heavy grazing has resulted in trampling and the washing away of much of the soil around the tree roots.

Rabbits have proved very destructive to young trees during the winter months. Poison bait and woven wire fencing have not proved entirely successful in preventing damage. The rabbits often dig under the fences or go over them when the fences are covered with snowdrifts. Poison baits are very undesirable as they are often not eaten by rabbits and it is difficult to keep them out of reach of domestic animals. Community rabbit drives offer at present the best means of reducing the number of these pests.

Fig 37 illustrates the use of a wire guard around a tree to prevent rabbit damage. The cost of wire guards is prohibitive for general use. However, the method is very effective when the wire is available. This method is often used for more valuable ornamental and specimen trees.

Fig. 36.—Heavy grazing as illustrated on the left side of picture tramples and packs the ground, injuring roots and lessening the moisture absorbing capacity of the soil.

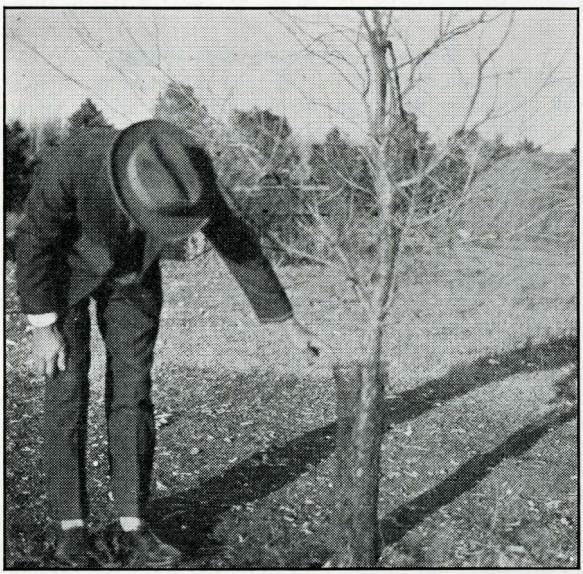

Fig. 37.—A woven-wire guard which will prevent damage to young trees by rabbits.

Geographic Conditions

With the exception of the Black Hills in the southwestern portion, South Dakota lies in a plains region and is divided into two nearly equal parts by the Missouri River.

The eastern half is in the level glaciated Prairie Plains region and practically all of it can be cultivated. The lowest point in the state is 967 feet above sea level at Big Stone lake in the northeastern corner. Except for a small area in this section of the state, the elevation of the eastern half varies from 1,000 to 2,000 feet above sea level.

The western half of the state lies largely in the unglaciated Great Plains region. The topography is from rolling to broken, and agricultural areas are restricted by topography, soil and climatic conditions. Excluding the Black Hills proper the elevation of the western half of the state varies from 1,000 to 4,500 feet above sea level. Harney Peak, 7,242 feet above sea level is the highest point in the state.

Climate

The amount of precipitation is the most important factor in the growing of planted trees in South Dakota.

The average annual precipitation as shown in figure 38* is greatest in the extreme southeastern corner of the state where 24 inches or more is received. The amount gradually diminishes toward the north and west, being lowest in the northwestern corner where it falls below 15 inches. There is an area in Brown and Spink counties, and another adjacent to the Black Hills where the amount of rainfall received is slightly greater than that for the adjoining farm regions.

Figure 39, which presents the total annual precipitation for South Dakota over a period of 50 years gives the normal precipitation as 23.91 inches for that part of the state east of the center line of the Shelterbelt, and for the part of the state west of the center line as 18.91 inches. These figures can not be applied to small areas. Specific locations are likely to vary from the normal, receiving either more or less than the average of the respective part of the state.

The eastern one-fourth of the state has a normal precipitation which is 5 inches greater than the western three-fourths. Even during years of above normal rainfall in the western three-fourths of the state, the amount generally falls short but occasionally exceeds by a small amount the normal precipitation for the eastern one-fourth of the state.

The state is subject to extremes in temperature varying from 115 degrees above to 50 degrees below zero. Sharp changes in temperature during winter months rather than extreme cold weather cause the most damage from low temperatures. During summer months, high temperatures together with dry winds are especially damaging to trees during periods of low rainfall.

Winds having an average velocity of 10 miles per hour prevail throughout the year, coming from the northwest during the winter months and from the south and southeast during the summer months. Continuous winds and low humidity cause high transpiration from trees. Dry summer winds when occurring during periods of low rainfall are especially injurious to trees because more moisture is given up than can

* Precipitation data from "Possibilities of Shelterbelt Planting in the Plains Region," Lake States Forest Experiment Station, Saint Paul, Minnesota.

be replaced from the ground. Wind will cause trees to give up moisture during warm periods in the winter but due to the frozen condition of the ground it can not be replenished, and this results in winter killing.

Soil and Tree Relationship

In a broad classification tree plantations in the state are either on upland or bottomland.

The latter includes only six per cent of the total number. The bottomland areas occur largely along the sluggish flowing rivers of the eastern part of the state and around certain lakes. The more rapid flowing rivers in the western half cut deep channels and because of better drainage much smaller true bottomland areas are formed. Bottomland is characterized by low wet soils with a high water table within 5 to 15 feet of the surface. They are ordinarily well drained and all trees that are hardy to the climate grow well on bottomland soil, unless periodically inundated.

Uplands, including the terraces or land above the first bench, contain 94 per cent of the present tree planting sites and it is here that the major problems in tree planting in the state occur.

From a tree planting standpoint four general soil classes as influencing tree growth are found in the state: sand and gravel, sandy loams, fine textured, and heavy soils.

Sandy and Gravelly Soils. The largest areas of sand and gravelly soils, which include loamy sands and loamy fine sands, are found in the Glacial Lake Dakota area in Brown and Spink counties; in the dune sand

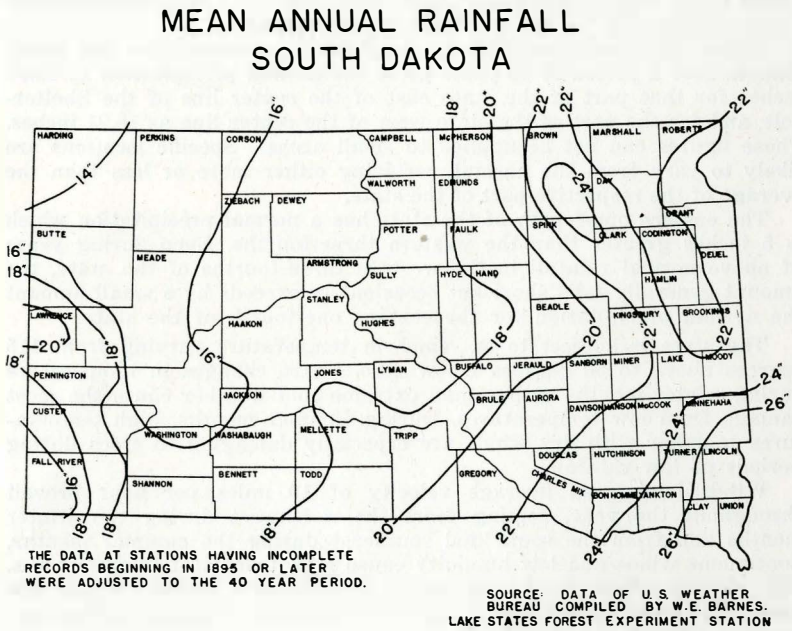

Fig. 38.—Mean annual rainfall in South Dakota.

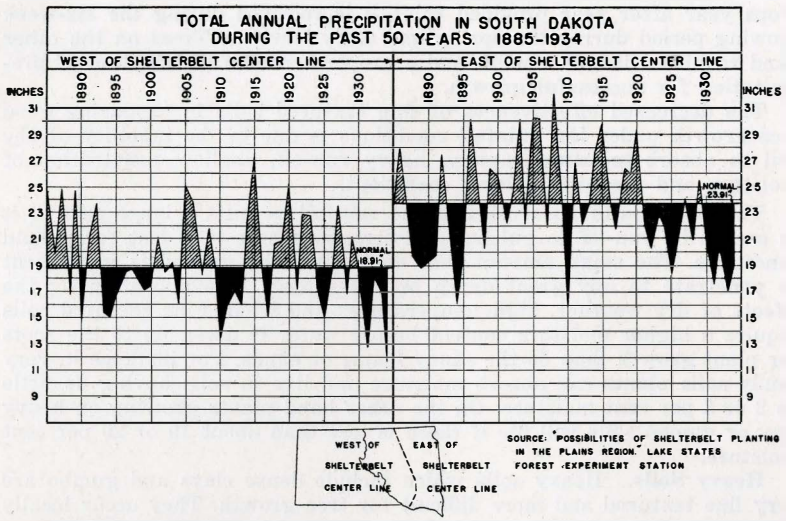

Fig. 39.—Total annual precipitation in South Dakota during the past 50 years.

areas along the southern border of the state which are an extension of the Nebraska sand hills; in Sanborn county along the James River; in the central portions of Campbell and Walworth counties. Many of the larger streams have narrow strips of sand and gravelly soils along the bottomland and adjacent terraces. The unglaciated western half of the state has many gravelly knobs and ridges. Sand and gravelly soils absorb precipitation rapidly. These sandy soils usually have a high water table level and have the ability to absorb most of the annual precipitation. Most trees hardy to the climate grow well and have a long life. Ridges with coarse gravelly subsoil are very difficult sites for tree growth because of their excessive under drainage and inability to hold moisture in the zone where roots occur.

Sandy Loam Soils. Sandy loam soils which include sandy loams and fine sandy loams are very favorable to tree growth. These soils absorb moisture quite rapidly and have adequate percolation and drainage. Roots penetrate to a greater depth and the trees grow vigorously and have longer life than on fine textured or heavy soils.

Fine Textured Soils. Fine textured soils which include very fine sandy loams, loams, silt loams, silty clay loams, and clay, vary in their ability to produce tree growth according to the amount of rainfall and water table level. Where sufficient moisture is available trees grow well on fine textured soils. These soils have a high moisture holding capacity, but they absorb precipitation slowly.

A large percentage of our tree plantations occur on upland situations and on soils which fall in this class where the amount of precipitation is barely sufficient for favorable tree growth. It is on these soils that the most severe losses in planted trees occurred during the drought of the past several years.

Fine textured soils are capable of producing satisfactory small grain

crops year after year provided rainfall is received during the six-week growing period during the spring and early summer. Trees on the other hand require a larger amount and a proper seasonal distribution of precipitation for successful growth.

The decreased effectiveness of fine textured soils in producing good tree growth under low rainfall conditions is due to the inability of the soil to absorb moisture rapidly, heavy run-off, shallow penetration of moisture and the high wilting coefficient.

The slowness of absorption of the rainfall permits a large part of it to escape by run-off to gulches and streams where it is lost for upland conditions. The small amount that does enter the ground is insufficient to penetrate to any great depth and is subject to evaporation by the effects of dry weather, high temperatures and wind. Fine textured soils require a higher moisture content before water is given up to the roots for plant growth than do the sandy loams or sands. For instance in very sandy soils plants can absorb moisture and live in soils having as little as 2 or 3 per cent moisture. On the other hand plants growing on heavy clay or gumbo soils will die if there is less than about 19 or 20 per cent moisture.*

Heavy Soils. Heavy soils which include dense clays and gumbo are very fine textured and more difficult for tree growth. They occur locally throughout the extensive areas of fine textured soils both in the eastern and western half of the state. This class of soil unless irrigated is unsuited to all except the most hardy trees. In basins and on poorly drained areas saline and alkaline conditions occur due to concentration of mineral salts which are not carried away by either surface or sub-surface drainage.

Zone of Lime Enrichment. Most soils in South Dakota usually show an accumulation of calcium carbonate (lime) in the subsoil.

"The zone of lime enrichment is a product of the vegetation, climate, and parent soil material. Practically all the geological formations from which the soils of the shelterbelt area have developed contain lime. The roots of the grass plants bring the calcium and other basic compounds within reach to the surface horizons. Upon decay of the grass, these compounds are released and carried downward by moisture. Thus the topmost soil layers are gradually cleared of lime. But where precipitation is insufficient to penetrate the soil deeply, the soluble compounds are leached to a comparatively shallow level, where they are reprecipitated and gradually accumulate to a maximum concentration. Thus there is built up, under a topsoil practically free of lime, a layer of higher lime content than occurs elsewhere in the entire soil profile.

"A zone of lime enrichment is not usually present in the more sandy soils of the region nor in the alluvial soils along drainage ways. Neither is it present in some of the soils occupying undrained upland basins where the moisture, accumulating from both precipitation and run-off, is sufficient to remove the lime to the water table."†

Trees which made their early growth during a period of dry years have been found to extend their roots down to the zone of lime enrichment and then cease further root development except laterally. Moisture

* Russell, J. C. and Burr, W. W., "Studies of Moisture Equivalents of Soils," Soil Science, Vol. XIX No. 4, April 1925.

† Possibilities of Shelterbelt Planting in the Plains Region." Lake States Forest Experiment Station, Saint Paul, Minnesota.

during subsequent wet years penetrated the zone and the tree roots sometimes extend to a greater depth. Lack of moisture and of proper aeration is believed to be the limiting factor in root penetration rather than to toxic properties of the lime zone.

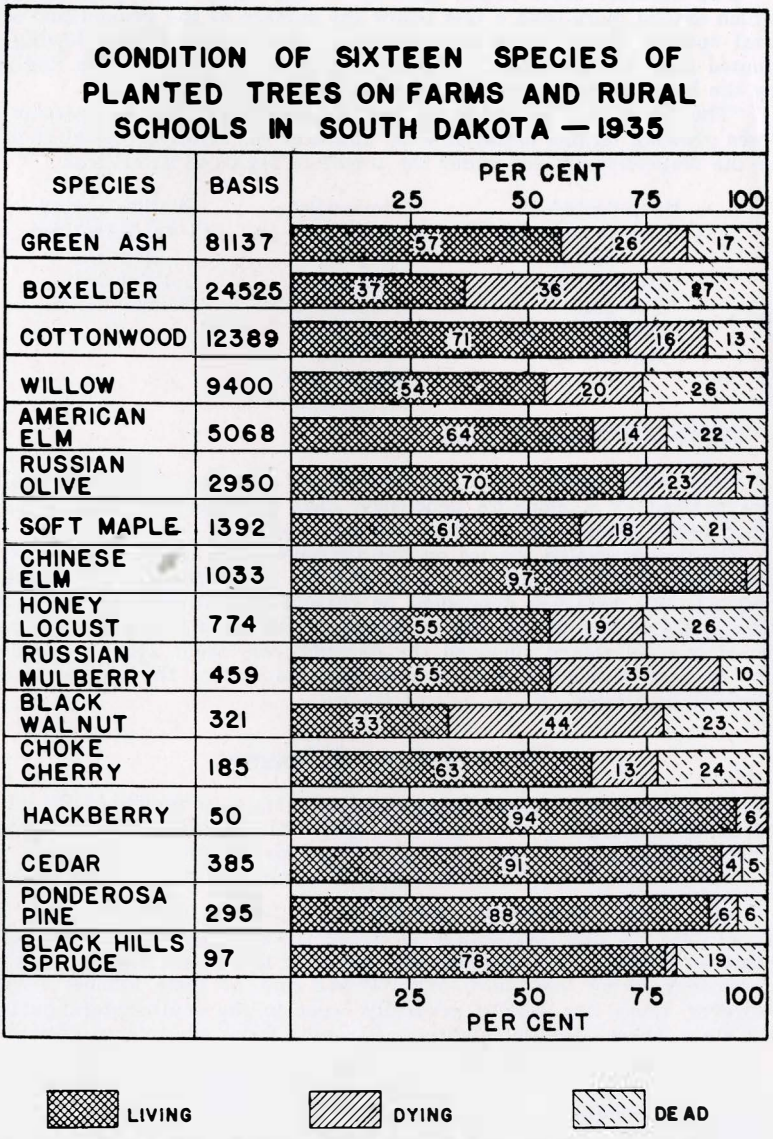

Fig. 40.—Conditions of standing trees of 16 species in plantations in South Dakota, 1935.

Root Development. On sites where the water table level is out of reach of tree roots (about 20 to 30 feet below surface) rooting is generally deeper on sands and sandy loams than on fine textured and heavy soils.

The hardiest trees found planted in the state have root systems which extend more than 5 feet below the surface of the ground and several species extend their roots down 10 to 20 feet. The following is quoted from "Possibilities of Shelterbelt Planting in the Plains Region" by the Lake States Forest Experiment Station.

"The following list, based on the observance of 84 root systems of trees growing on fine textured soils, indicates the relative rooting depths of the respective species under the condition regarded as critical.

Deep-rooted (10 to 20 feet in depth)	Intermediate (5 to 10 feet in depth)	Shallow-rooted (1 to 5 feet in depth)
*Honey locust	Red cedar	Cottonwood
*Bur oak	Russian olive	Golden willow
*Ponderosa pine	Caragana	
**Hackberry	Boxelder	
	*Green ash	
	**American elm	

* Usually strongly tap-rooted.
** Occasionally strongly tap-rooted.

The species listed in the first and second columns, although more or less injured by a moisture deficiency, have survived the long drought much better than those listed in the third column."

The deeper rooted species on fine textured soils have survived better than those having shallow roots during the past several years drought because they were less dependent on current rainfall and top soil moisture. Some of the species like caragana or red cedar which are not particularly deep rooted survived the drought very well. This is probably due in part to wide spreading root systems and to the ability to cut down transpiration by the loss of leaves.

Description of Species

The percentage of living, dying and dead trees as presented in Fig. 40 is based upon standing trees and not upon the original number planted. These figures are not intended to be used as survival percentages but in most instances they furnish a basis for comparing the different species.

All of our Chinese elm plantations are young, few being over 15 years old. The high percentage of living trees at present is not a good basis for judging the hardiness and longevity of Chinese elm. Soft maple and honey locust both have over 50 per cent of their number living; however, these two species generally occur in the southeastern part of the state where climatic conditions are more favorable to tree growth.

Green ash has withstood a very heavy loss from insects, yet the percentage of living trees is comparatively high. Cottonwood indicates that it is more drought resistant than generally believed. Cottonwood is also more generally used for fuel wood than other trees and there is a smaller per cent of dead trees left standing.

Broadleaf Trees

American Elm (*Ulmus americana, Linnaeus*).—The American elm is native throughout the state and is found growing along rivers, streams, in dry gulches and draws and around lakes. It is widely planted and a good survival indicates its ability to grow under varying conditions.

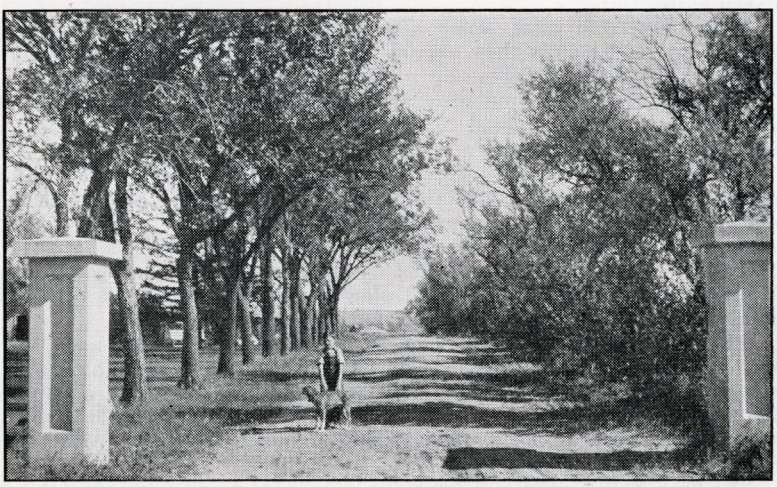

Fig. 41.—Farm lane made attractive by planting American elm and Russian olive.

This tree reaches its greatest size on sand, sandy loams and loessial soils, attaining heights of 50 to 60 feet and diameters up to 24 inches. On the fine-textured soils heights of 20 to 35 feet and diameters of 6 to 12 inches are attained. The tree grows to an age of 60 years or more on the better sites. In the dryer regions, however, and on heavy soils signs of dying are noticeable at 20 to 30 years. The root system reaches a depth of 5 to 10 feet and occasionally produces a strong tap root.

American elm is one of our most popular shade and ornamental trees. Seeds are produced in May before the leaves are out and must be planted immediately. The wood is used chiefly as fuel. The tree is not attacked to any great extent by insects.

Black Walnut (*Juglans nigra Linnaeus*).—Black Walnut is native to the southeastern part of the state. It has been found growing in plantations in every county east of the Missouri river and in many in the western part.

This species has suffered severely from the drought. It does not produce much shade or wind protection and because of its lack of hardiness on dry sites it is not well adapted for farmstead shelters. However, a few of these trees planted on favorable moisture sites will furnish domestic supplies of black walnuts as well as valuable wood supplies when the trees become mature.

Irrigated trees which are nine years old in a city park at Pierre, in Hughes county, have been bearing nuts for two years. Where trees are planted in farmstead shelters and are not irrigated, it ordinarily requires

10 to 15 years before they bear fruit. In a large grove in Lincoln county, black walnut trees reached a height of 40 to 50 feet and diameters of 12 to 14 inches. There are notable examples of black walnut groves in Brown, McPherson, Campbell, Walworth, and Edmunds counties where the trees attain heights of 40 to 45 feet and diameters up to 12 and 14 inches. The climatic conditions here are as severe as any place in the eastern part of the state.

Only nuts from trees which have grown within the state should be planted and if possible they should be collected from trees which have demonstrated their hardiness by growing to maturity in the locality.

Black walnut is a rapid growing tree and develops a deep root system. It is naturally adapted to rich well drained bottomland soils and does not grow well on sandy soils.

Boxelder (*Acer negundo Linnaeus*).—Boxelder is a native tree found growing throughout the state along streams and around lakes. Because of its abundance and ease of propagation it was one of the most extensively planted trees during the period of early settlement.

This tree has proved to be short lived, especially on the uplands, and it is not recommended for general planting except in Zones 1 and 3. It is recommended for Zone 2 if restricted to sandy soils.

This tree attains heights of 50 to 60 feet on sand and sandy loam bottomlands and attains ages of 60 years or more. It makes fair growth on upland sand and sandy loam soils. Boxelder is short lived on upland fine textured soils and of low bushy growth, attaining a height of 15 to 30 feet. The root system for upland situations is of the intermediate class, generally varying from 5 to 10 feet.

The favorable features of boxelder include its rapid early growth and bushy form affording early wind protection. This is one of the first trees to leaf out in the spring, and it produces an abundance of shade and protection during the summer.

The tree is infested by disease and insects and does not produce a straight trunk. The wood is used mainly for fuel although it is not considered desirable because of the poor quality and the difficulty in working up of the rough and limby trunks. There are so many other more desirable trees than boxelder that it is not generally recommended.

Buffalo Berry (*Shepherdia argentea Nuttall*).—Buffalo berry is a native shrub well distributed over the western part of South Dakota. Its name, it has been claimed, was derived from the fact that its berries were eaten as a sauce along with buffalo meat. The red or yellow berries are used in making jellies, and they supply a valuable source of food for birds. Buffalo berry is hardy to cold and considered resistant to drought, though heavy losses in native stands of this species have been noted on clay and shale hillsides. It does not thrive in low wet places.

This shrub generally attains a height of 4 to 8 feet, but will reach a height up to 18 feet on the more favorable sites. Buffalo berry produces a thick thorny hedge and is suitable for outside rows of farmstead shelters.

Bur Oak (*Quercus macrocarpa Michaux*).—Bur oak is found throughout South Dakota growing along streams, in ravines, and on bluffs. It is found growing naturally in some of the driest sections of the state.

Because of the difficulty of transplanting the deep rooted seedlings and due to its slow growth very little oak is planted. Nursery methods have not been perfected whereby oak can be successfully established in

plantations from seedlings. At present the only feasible method known is to plant acorns in place and protect the seed from rodents until after germination.

Bur oak possesses many of the characteristics of the best plains trees which include slow growth, long life and a deep root system. The acorns supply food for small animals. Further experiments are necessary both in the nursery and in field planting to determine the ultimate possibilities of this tree.

Fig. 42.—Four-year-old Chinese elm plantation near Dell Rapids, South Dakota.

Caragana or Siberian Pea-tree (*Caragana arborescens Lamarck*).—This drought resistant shrub growing on the plains of Siberia was introduced into the United States some years previous to 1897. Since its introduction, it has been planted extensively over the Northern Great Plains and has proven its adaptability for windbreak purposes. One hedge planted in South Dakota in 1900 from imported seed is still alive. It is especially valuable for outside rows because it branches profusely near the ground, retains nearly all of its branches, and generally reaches a height of 8 to 15 feet. Caragana may be grown on all types of soil except sand or gravel but it does not thrive in low wet places. It is resistant to severe cold and will tolerate a small amount of alkali. It develops a thick mat of roots which generally penetrate the soil to a depth of 5 to 10 feet. Although blister beetles and grasshoppers might eat the leaves of this shrub, serious damage is not done unless there is complete defoliation or considerable defoliation is repeated for a number of successive years.

Chinese Elm (*Ulmus pumila Linnaeus*).—The Chinese elm was introduced into the United States in 1908 by the United States Department of Agriculture. The tree has been planted throughout the state during the past 15 years and as a young tree it has proven a very satisfactory species for farmstead shelters and windbreaks.

Of all the broadleaf trees planted in the state, Chinese elm is outstanding for its ability to grow and thrive without special care on the

fine textured soils of the dry uplands. It grows well on all classes of bottomland and upland soils except dry sand or dune areas. Young trees of most species do remarkably well even during dry periods and it is for this reason that it is felt that the planted trees of Chinese elm in South Dakota are not old enough to furnish a reliable indicator as to its longevity and final value under upland plains conditions.

It is a rapid growing tree reaching a height of 8 to 12 feet and a diameter of 4 to 6 inches in 5 years. The oldest Chinese elm in the state is 24 years old, planted at the Belle Fourche Field Station near Newell. This tree has attained a height of 36 feet and a diameter of 10 inches. A study of a 16-year-old irrigated grove at the same station disclosed that heights varied from 30 to 45 feet and diameters averaged 9 inches.

Out of a total of 30 trees all but 6 had trunk rot. The tree is subject to sun scald and wounds do not readily heal over. The pruning of side branches should be avoided to lessen the possibility of disease.

Chinese elm produces a very satisfactory hedge or stock barrier when planted close together in rows.

Chokecherry (*Prunus virginiana Linnaeus*).—Chokecherry is native throughout the state. It grows naturally on bottomlands and in ravines and on north hillsides. It is not extensively planted though it is one of the most hardy shrubs in the state and can be substituted for caragana or Russian olive.

This tree-like shrub produces excellent food and provides cover for upland game birds. The fruit is suitable also for jellies and preserves. Heights of 10 to 15 feet and diameters of 4 to 6 inches are generally attained. The root system penetrates to a depth of 5 feet.

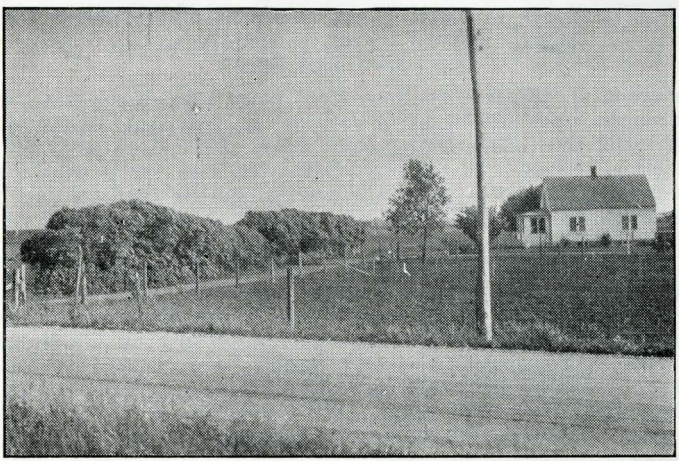

Fig. 43.—Lilac hedge near Volin, South Dakota. Heights of 12 to 15 feet are attained frequently.

Cottonwood.—There are two cottonwood trees native to South Dakota which are important in tree planting in the state. *Populus deltoides virginiana* (Sudworth), extends throughout a large part of the state. The cottonwood in the western part of the state is known as *Populus sargentii* (Dode) or Sargents' cottonwood. It is very similar to the eastern tree except that it does not attain as large a size.

The cottonwoods are the largest trees in South Dakota and make their best development along the moist sandy banks of the Missouri river. They occur along living streams and around lakes but do not grow in dry water courses and gulches as American elm, green ash, and hackberry characteristically do.

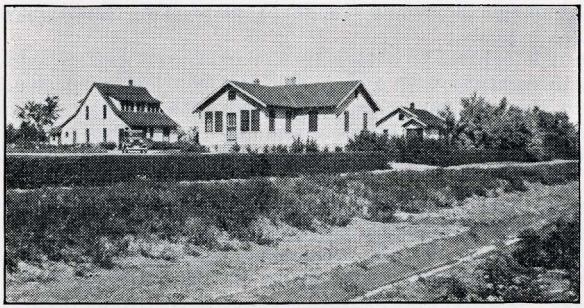

Fig. 44.—Chinese elm hedge, Belle Fourche Field Station near Newell, South Dakota.

The cottonwood tree has been planted extensively in the older plantations. It is very successful on moist bottomland sites and on areas having a sandy soil with a high water table. Cottonwood is not drought resistant and will not survive long on upland fine textured soils. If cultivated it will make rapid growth on such sites for 10 to 15 years but will die at a relatively early age.

On moist sand or sandy loam soils cottonwood attains heights up to 80 feet and diameters of 40 inches or greater. The average height of the largest trees is 65 feet and average diameter, 20 inches. Cottonwood is recommended for general planting in Zones 1, 3 and 6 and also for the sand and sandy loam soils of Zones 2 and 4.

The wood is used extensively for fuel and makes good fence post material when creosoted.

Cottonwood seedlings are found growing naturally along the sandy banks of streams and on lake shores. It is here where much of the early planting stock was secured. The Forest Service has secured several million seedlings from this source which they have planted on moist sandy soils under the Great Plains Shelterbelt Project initiated in 1934. A large part of the planting stock is dug in the fall and put in cellars or cold storage over the winter.

Green Ash (*Fraxinus pennsylvanica, var. lanceolata, Sarg.*).—The green ash is found native throughout the state, occurring along streams, dry water courses and around lakes. It is the most widely planted tree in farm plantations and because of its ability to grow under the most severe climatic and soil conditions throughout the state it is one of our most desirable trees. It endures very dry sites and is hardy against heat and cold.

The tree grows well on all classes of soils on bottomland and adapts itself remarkably well to dry upland situations, although height and diameter growth is considerably reduced. It endures a small amount of alkali.

The tree is of medium to slow growth and in plantations generally attains a diameter of 6 to 10 inches and a height from 30 to 40 feet. It has a long life. Under the most favorable conditions heights of 60 feet and diameters up to 2 feet were found. The root system is of the intermediate type reaching a depth of 5 to 10 feet and usually having a strongly developed tap root. The wood is heavy and strong and serves many useful purposes around the farm, as well as supplying good fuel wood and fence posts.

Because it is subject to attack by borers, other species should always be planted in mixture with green ash and the latter species should be restricted to two to four rows. A mixture is also desirable because of the natural intolerance of ash to shade and the late opening of its buds. Not enough shade is produced to prevent the establishment of grass beneath the trees.

The tree sprouts very readily when killed back near the ground and will produce a new windbreak from sprouts which will become effective in four to five years. It also responds readily to top trimming when dead top branches are cut back below the line of dead wood.

Hackberry (*Celtis occidentalis Linnaeus*).—Hackberry is native throughout the state, although it occurs infrequently west of the Missouri river. It is rarely found making up a large amount of a stand of timber, but occurs as scattered individuals on bottomlands, on ridges between lakes, on steep slopes, and in dry gulches.

The scarcity of seed, the difficulty of transplanting the deep-rooted wild seedlings, and the slow growth made by the tree have prevented the general use of hackberry in plantations. The planting of this tree should be greatly increased.

Hackberry is very hardy to drought and cold and adapts itself very well to dry upland fine textured soils. It has one of the highest survivals of all trees planted and is recommended for planting throughout the state.

This tree resembles the American elm but is smaller and more symetrical. It is slow growing and has a long life. Hackberry attains heights of 50 feet and diameters of 16 inches on the more favorable sites, though on upland situations it rarely exceeds a height of 30 feet and a diameter of 8 inches. It has a deep root system, extending to a depth of 10 to 20 feet, and a well developed tap root.

Honey Locust (*Gleditsia triacanthos Linnaeus*).—Honey locust is native to the southeastern part of the state, growing naturally in Union, Clay, Yankton and Bon Homme counties. It has been planted throughout the state but mostly in the southern part of the eastern half.

This tree grows best on sand and sandy loam soils but does well on all bottomland soils and makes a moderate growth on upland sites. It is not considered exacting in soil or moisture requirements. When planted in the northern and western part of the state fair success has been obtained and a more general use of this tree is justified.

Heights varying from 40 to 50 feet are attained on the more favorable sites and diameters reach 12 to 14 inches. On upland fine textured soils sizes are considerably reduced. The honey locust has a deep root system extending from 10 to 20 feet in the soil, and it develops a strong tap root.

The tree produces an abundance of shade, has strong limbs and

branches and it is not often injured by wind or ice storms. It is very wind firm and is particularly free from insect and disease attacks.

Lilac (*Syringa vulgaris Linnaeus*).—Lilac is a native of central Europe and the Orient but has proved one of the hardiest shrubs for the prairies of South Dakota. It is exacting in neither soil nor moisture requirements and its ability to produce a thick dense hedge makes it a very valuable shrub for wind protection. Lilac generally reaches 6 to 10 feet in height and occasionally attains a height of 20 feet.

When planted as the first row next to the house, in a farmstead shelter, it provides not only wind protection but is fragrant and attractive flowers give it much value as an ornamental shrub.

Russian Olive (*Elaegnus angustifolia, Linnaeus*).—The Russian olive, a native of Europe and Asia, has been planted extensively over the state, and is one of our most desirable trees for farmstead shelters and field windbreaks. It grows to be a tall shrub or small sized tree, reaching a height of 10 to 25 feet. Unless pruned while young it forks close to the ground and forms 2 to 4 main stems ranging in diameter from 3 to 6 inches. Single-trunked trees rarely exceed 8 inches in diameter. The largest tree found in the state is 40 feet high and has a diameter of 21 inches. The tree grows fairly rapidly and the root system extends from 5 to 10 feet in the soil. Trees which have been planted 16 years at the Belle Fourche Field Station near Newell have attained average diameters of 3 inches and heights of 13 feet on dry land and under irrigation average diameters of 4 inches and heights of 20 feet.

The tree does well on dry sites and on well drained irrigated soils. It does not thrive on poorly drained bottomland sites. It is not particular about soil requirements and grows well on upland heavy soil and somewhat alkaline situations. The tree is hardy against drought, heat and cold and is one of our most valuable species for farmstead shelters. Because of its height and habit of growth it is especially adapted to outside rows in plantations. When planted close together it will produce a thick hedge and will keep out livestock. Individual trees well trained are very popular as shade and specimen trees, the silver color of the leaves being valuable for landscaping. This tree produces an abundance of seed early in the summer and it germinates readily. The fruit has some value for birds and small animals.

Silver or Soft Maple (*Acer saccharinum Linnaeus*).—This tree occurs naturally in the southeastern corner of South Dakota and is planted mainly in the southern part of the eastern half of the state.

Soft maple makes its best growth on wet bottomland soils. It grows well on sand and sandy loam soils. It is not adapted to dry upland situations, where it makes poor growth and is short lived. This tree is recommended for general planting only in Zones 1 and 3.

The maple produces an abundance of shade and is a desirable tree where it can be grown successfully. Heights of 50 feet and diameters of 24 inches are common on the more favorable sites. The wide spreading and imposing crown gives it a place in ornamental planting.

Tartarian Honeysuckle (*Lonicera tartarica Linnaeus*).—Tartarian honeysuckle is an example of another successfully introduced Siberian shrub. As a shrub suitable for planting on the inside row, there are few if any more hardy and less exacting in soil and moisture requirements. It can be propagated easily by planting cuttings. Branches are retained from the ground up, which in some cases is 15 to 20 feet. The

decorative spring flowers add color to the plantation and the berries provide food for birds. As a general rule, it is very free from insect attacks.

White Willow (*Salix alba Linnaeus*).—White willow is a native of northern Europe and Asia, but was brought to this country early in its development and was later extensively used for windbreak planting on our prairies.

White willow has a shallow root system extending from one to five feet into the soil. It requires wet, moist sites and will not survive except on bottomland or on soils having a high water table. It has been planted extensively in the past on upland sites where the loss has been very great. This tree is one of the lowest in survival of those commonly used in plantations.

White willow is recommended generally for Zones 1, 3 and 6 and for the sand and sandy loam soils of Zone 2. This tree grows rapidly and attains heights of 50 to 60 feet and diameters of 24 inches or more.

The wood is chiefly valuable for fuel. Although attacked by several insects none of them appear to be very damaging.

Wild Plum (*Prunus americana Marshall*).—Native wild plum occurs throughout the state along streams and around lakes. It has been planted to some extent in groves where it suckers and produces dense thickets. Wild plum has not proven as hardy to drought during the past few years as Russian olive, caragana or chokecherry. Its habit of producing a low bushy growth at the edge of plantations is very desirable. The fruit makes good jellies and preserves and also supplies food for upland birds. Wild plum attains heights up to 20 feet and diameters of 4 to 6 inches. It is recommended for general planting in Zones 1, 2, 3, and 6.

Evergreen Trees

Black Hills or Western White Spruce (*Picia glauca albertiana Rehder*).—This tree is native to the Black Hills region and has been found to be fairly hardy when planted throughout the plains areas of the state. Spruce will grow on fine textured upland soils and will withstand a moderate amount of drought. It does not survive as well as the cedars or ponderosa pine. This tree will attain heights of 20 to 25 feet in 30 years on fine textured upland soils. On more favorable sites it will reach 40 to 50 feet in height and attain diameters of 10 to 12 inches.

Black Hills spruce is recommended for general planting in Zones 1, 2, 3, and 6. It is one of the most efficient trees for windbreak purposes and its use should be more general. It is also valuable for ornamental purposes.

Blue Spruce (*Picea pungens Engelmann*).—The blue spruce is a native of the Rocky mountains of Colorado, Wyoming, and Utah but it is finding a place in ornamental and windbreak plantings of South Dakota

This tree grows well on sand and sandy loam soils and does fairly well on the fine textured upland soils excepting in the driest parts of the state. Blue spruce grows naturally on moist sites but will withstand considerable drought after it is once established. It has proven equal to the Black Hills spruce for hardiness to drought. Blue spruce is recommended for planting in Zones 1, 2, 3, and 6.

Eastern Red Cedar (*Juniperus virginiana Linnaeus*).—

Rocky Mountain Red Cedar (*Juniperus scopulorum Sargent*).—The two native cedars were found to have the highest survival of the evergreen species. The dense foliage provides protection both winter and summer.

Cedar is hardy to drought and cold and is especially adapted to growing on the fine textured soils of the uplands.

The tree is slow growing. Under average conditions it will attain a height of 15 to 20 feet in 30 years and a diameter of 6 to 8 inches. Cedar grows to an old age. It has a wide-spreading root system which penetrates to a depth of 5 to 10 feet. The wood is very durable when in contact with the ground and is used extensively for fence posts.

A disease known as cedar rust lives for a time on the cedar and then on apple trees. For this reason cedar should not be planted near apple orchards.

Ponderosa Pine (*Pinus ponderosa Lawson*).—This tree is found throughout the Black Hills, on the higher buttes in Harding county, and in scattered blocks in deep canyons or on ridges as far east as the Rosebud Indian Reservation in Todd county.

Ponderosa pine is the important commercial timber tree of the state. Because of its adaptability to upland plains conditions this tree has been found to be one of our most desirable trees for farm planting. It is hardy to drought and cold and furnishes year-round wind protection because it retains its long green needles throughout the year. It is recommended throughout the state.

This tree grows best on a sand or sandy loam soil but develops remarkably well on dry fine textured soils. On upland fine textured soils heights of 25 feet and diameters of 10 inches have been attained in 30 years. The tree is long-lived and has a root system which penetrates to a depth of 10 to 20 feet on upland soils.

The wood is useful for fuel, lumber, and posts. Attacks of the pine tip moth occasionally cause damage but the ravages of this insect are not widespread.

Summary

Moisture is a very important factor in tree growth. However, with the selection of hardy trees and proper class of planting stock, and with reasonable care of plantations, trees will grow successfully on farming land throughout the state.

Planting stock should be from northern grown trees which have demonstrated their ability to grow under the climatic conditions existing in South Dakota. In general the slower growing and deeper rooted species are the most successful.

The most commonly planted trees make their best growth on sandy and sandy loam soils. The fine textured and heavy upland soils are the most difficult and should be planted only with the hardiest species.

Certain trees have a wide range of adaptability and will survive to some extent under very severe soil and climatic conditions. The following species are hardy statewide: Eastern and Rocky Mountain red cedar, ponderosa pine, hackberry, Chinese elm, green ash, American elm, honey locust, Russian olive and bur oak.

Other species commonly planted will succeed only on the lighter soils where moisture and physical conditions are the most favorable. They include native cottonwood, boxelder, white willow, soft maple, black walnut, and Black Hills and blue spruce.

Prepare planting plan in advance. Protect buildings and feed lots on the north and west. Plant trees at least 100 feet away from buildings. Protect crops and gardens on the south and west.

Summer fallow sod land two years and other land one year before planting.

Use young planting stock either nursery grown or wild seedlings. Broadleaf species should be 1 to 2 years old and from 12 to 24 inches high and evergreens from 2 to 6 years old from 6 to 12 inches high. Only spring planting should be practised.

Rows should be planted 6 to 8 feet apart with the trees 6 feet apart in rows. Shrubs such as caragana, lilac, honeysuckle and buffalo berry should be planted 3 feet apart in rows. Under the driest conditions a spacing between rows not to exceed 12 feet may be used provided clean cultivation is practised.

Cultivation of young plantations to keep down the growth of grass and weeds should be continued as long as it is possible to work horse-drawn implements between the rows. A strip of ground at least 12 feet wide around the edge of the plantation should be kept in clean cultivation at all times. Mulching as a substitute for cultivation has not proved satisfactory.

Best results are obtained when two or more kinds of trees are planted. Plant the tallest trees in the center rows and the shortest trees and shrubs in the outside rows.

Evergreens are particularly hardy, long lived, and effective for wind protection and in shading of the ground. They add much to the beauty and color of the landscape and their use should be more general.

Exclude all classes of livestock from plantation by a substantial fence, woven-wire preferred. Plantations regularly grazed show a decidedly higher per cent of dead trees than those ungrazed.

Every farm and most rural schools should have a tree plantation of 1 to 3 acres for a shelter. Farms should devote at least 5 acres to the growing of trees for a farmstead shelter, a woodlot and field windbreaks.

Pruning the lower branches of trees is very objectionable and should be done only to insure a main central trunk for the taller trees in the middle rows. Trees which have died back on top can be benefited by careful trimming of the dead branches.

To minimize insect attacks maintain the vigor of the trees by cultivation of the younger plantations and by the exclusion of grazing and fires. Insects do not develop well under dense shade as produced by close spacing.

Planting for the protection of homes has been generally practised although there is much need for further work along this line. School and field windbreaks have been almost entirely neglected. The Forest Service through the Plains Shelterbelt Project will establish a large number of field windbreaks. There will be further need of planting for this purpose outside the Shelterbelt Zone. A program for planting around rural schools is greatly needed.

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