hood of 12 tons of dry yeast. Because of its much smaller capacity, it could be installed at mills with comparatively small cut or in a community where there were several small mills from which wood waste could be made available.

In the long run it may be that this sort of development will be of the utmost importance to the West because, as you are all aware, this is an area of chronic protein deficiency. The turkey industry in Oregon and Washington alone is capable of consuming 100,000 tons per year of protein feed.

One more possibility that should be discussed, especially in the Northern Rocky Mountain States, is the possibility of industries founded upon a peculiar property of Western larch. This wood contains up to 20 per cent of a substance known as galactan, a water-soluble carbohydrate that is composed almost entirely of the sugar galactose. Galactose can be oxidized to mucic acid for which some market has existed in the past and for which a greater market could probably be created. A small industry was attempted some years ago in Montana for the extraction of this material and its oxidation to mucic acid. Perhaps such an industry will be more profitable if adequate provision is made for integration of other forms of byproduct utilization with mucic acid production. For example, it is conceivable that hogged larch could be packed in percolators similar to those in use at Springfield, the preliminary extraction with hot water being given to remove the galactan and then the residue subsequently hydrolyzed by the same process in use at Springfield for the production of a crude sugar solution. No pilot-plant installations known to the writer are at present using such a combination of processes.

In all these hydrolytic processes solid lignin is the residue. For the present no higher uses for it are available than as a mulch in nurseries and truck gardens or other purposes in which its physical form and general chemical make-up are satisfactory. Considerable work is in progress at the Forest Products Laboratory and elsewhere on the utilization of this material, and it is hoped that in the long run production from this source may become sufficiently profitable to help defray the general cost of operation. For the present, with alcohol prices at extremely high levels and supplies of other raw materials for alcohol at extremely low levels, the economic success of the Springfield plant does not seem to be much in doubt. What the future price of alcohol may be is anyone's guess, but our best calculations indicate that the Springfield plant will be able to hold its own in whatever may turn out to be normal conditions. If the byproducts of the plant come along as well as expected, it will do very well. Neither can one forecast the requirements for alcohol in this country very accurately.

These are only a few of what seem to be the most important possibilities for the establishment of wood-using industries in the Inland Empire. Waste utilization, as far as wood is concerned, cannot develop except upon the basis of primary wood-using industries that produce waste. This means that if a wood-using economy is to develop to its fullest extent in this or any other region, it must be based upon the production of quality lumber and similar products such as plywood and, on some lands, pulp. These primary products must carry the costs of growing trees, building access roads, and harvesting. The waste produced in growing, logging, and manufacturing will be far more than enough to provide the raw materials for many of the industries capable of using them.

Fundamentally, sustained yield of high-grade primary forest products should be our aim. There will be plenty of low-grade material upon which to base byproducts manufacture.

FOREST PROTECTION IN THE SILVICULTURE OF WESTERN WHITE PINE FORESTS

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Until about twenty years ago, forest protection was considered an integral part of silviculture. But in more recent years, with increasing specialization in fire, insects, and disease control, there has been a tendency to consider protection as a separate phase of forest management. This trend, unfortunately, has occurred at a time when silvicultural practices have become more intensive. Only by a correlation and integration of protection, economics, and silvics can a sound practice of silviculture result. The purpose of this paper is to show how important forest protection is in the silviculture of Western white pine forests.

CONTROL OF FOREST INSECTS

Under an extensive type of silviculture, insect control must be direct. It has been demonstrated that timely and adequate application of insect control measures will usually keep infestations in check and reduce losses. The aim in direct control is to keep infestations endemic and to prevent the development of epidemics, which once under way are largely uncontrollable. This is the type of insect control we have had in white pine forests in the past.

Meanwhile, the forest entomologists have been insisting that the most promising form of control is through prevention of forest conditions favorable to the starting of epidemics. James C. Evenden of the Forest Insects Laboratory at Coeur d'Alene has told us many times that Western white pine becomes more susceptible to bark beetle attack as the result of overstocking which taxes the wood producing capacity of the soil. He believes that the overcrowding of stands is generally responsible for the development of bark beetle epidemics. When a general infestation of bark beetles develops, differences in individual tree susceptibility largely disappear. Hence, the most promising method of control consists of preventive measures aimed at keeping stands vigorous. This points to the use of partial cuttings which remove low-vigor trees, free thrifty trees from competition, and maintain stand vigor.

Partial cutting is a relatively intensive silvicultural measure. Because of economic reasons, it has not been practicable in the past in the Western white pine type. But recent developments such as truck logging and the greater utilization of mixed species make these cuttings economically possible.

Some measure of the practicability of partial cuttings as a means of harvesting trees which would otherwise be lost to insects and disease is given by results of three of our tests of very light cuttings. Two of these tests are located in 180-year-old stands on the Deception Creek Experimental Forest and one in a 130-year-old stand on Rapid Lightning Creek on the Kaniksu National Forest. The average five-year loss by insects, windthrow, suppression, etc., in comparable uncut stands has been ninety board feet per acre per year. In the lightly-cut stands, which averaged fifteen per cent volume removed in cutting, the loss has been fifty board feet per acre per year. Of the trees twelve inches and larger which have died on these test areas during the last five years, sixty-five per cent have been trees of poor and fair vigor. These results show promising possibilities for the use of partial cuttings as a means of harvesting potential mortality.

Silvicultural practices may also aid in control of another group of forest insects, the defoliators such as the tussock moth. M. Westveld delivered a paper at the recent Salt Lake City meeting of the Society of American Foresters on the silvicultural control of the spruce budworm in the northeastern United States. The cutting of old trees of poor vigor and the control of species composition are two methods he advocated. In the long run, we should find that intensive silviculture will materially aid in insect control.

CONTROL OF FOREST DISEASES

Forest diseases have always had a profound influence on the silviculture of the Western white pine type. The problem of how to dispose of defective trees, mainly grand fir and Western hemlock, in mature and over-mature stands, has in the past been the most difficult of all silvicultural problems. Various disposal methods have been tested and used since cutting first began in the white pine type on the National Forests in 1907. However, these practices have been costly and have been used only to a limited extent.

Quite recently we have come to the realization that the most serious of all forest diseases in the white pine type, white pine blister rust, must be considered in almost every silvicultural practice. This has resulted largely from the work of Virgil Moss of the Spokane Blister Rust Control Office. His studies have demonstrated that silvicultural practices can materially aid in blister rust control through the suppression of ribes. Moss has found that by leaving a residual stand of the proper density, ribes can largely be suppressed, partly through devitalization of seed present in the organic mantle of the soil and partly by the inability of plants which become established, to survive. He has also found that ribes can largely be eliminated by prescribed broadcast burn methods. In general, his results point to the use of partial cuttings in immature and mature stands, and prescribed burning in overmature stands. Prescribed burning may also be applicable at times in certain kinds of mature stands.

If we are to use partial cuttings as a means of suppressing ribes, we need field methods to estimate light intensities in residual stands in advance of cutting. Only in this way can we determine how heavy a cut is needed to leave the proper residual stand for ribes suppression. We have developed a simple method to do this, based on a correlation of light intensity beneath residual stands with a measure of stand density, summation of diameters at breast height. This measure of stand density can easily be computed from cruise data. All that is needed to determine the amount to cut to obtain any given light intensity are cruise data and a table which we have prepared.

FIRE CONTROL

Fire protection does not have as great an influence on silvicultural practice as do insect and disease control, yet it too affects these practices. It determines the intensity and methods of slash disposal. It limits, to some extent, the use of such practices as girdling. It determines when and how prescribed burning work shall be done.

CUTTING PRACTICES

Protection against insects, disease and fire, then, is constantly influencing silvicultural practice. Just how can these protection requirements be correlated with the silvical characteristics of the species into integrated rules of practice for the white pine forests?

The framework for this integration must be the silvical characteristics of the species involved. Western white pine is a fire type. Periodic fires have broken up the march of forests to the ecologic climax of Western hemlock, Western redcedar, and grand fir. Without these past fires there would be little white pine. The reason for this is that Western white pine is relatively intolerant. It cannot compete successfully under moderate to dense shade with its more

tolerant associates, grand fir, Western hemlock, and Western redcedar.

This characteristic of relative intolerance means that white pine cannot be grown in mixtures with its tolerant associates in all-aged stands. Even-aged stands with a final cutting by the clear-cut, seed-tree, or shelter-wood method are required for its continued production.

The same is true with other silvical characteristics. Each must be considered in relation to protection requirements and economic limitations in arriving at satisfactory practices.

Cutting practice recommendations have been formulated for National Forests which attempt to integrate the protection requirements and basic silvical needs of white pine. These recommendations are given below.

Immature Stands

In merchantable immature stands, generally less than 100 years of age, a series of improvement cuttings are recommended. The first objective is to harvest some timber. The other objective is to thin the stand in order to prevent the undesirable overcrowding mentioned earlier. Improvement cuttings should take out the trees which have the poorest possibilities for quality increment, such as inferior species, injured trees, and heavily branched individuals. Requirements for insect control are met by maintaining stand vigor. These cuttings also aid in blister rust control by exhausting ribes seed in the forest floor.

Mature Stands

Cutting practices for mature stands, 100 to 200 years of age, are the most difficult to develop because of the wide variation in stand conditions. The problem of blister rust control has forced us largely to abandon the old standby seed tree method. This method results in white pine and ribes seedlings coming in together following cutting; before the ribes are large enough to be eradicated the white pine seedlings may become infected with rust. This usually creates an impossible situation for the economic control of the disease; other cutting methods must be used.

Practices must be varied considerably in mature stands, depending on the potential ribes populations, stand vigor, and the amount of defective material in the stand; cutting practices must differ to some extent for each combination of these factors.

Vigorous stands with a light potential ribes population should be partially cut in order to get through the stands faster to salvage potential mortality and to get all stands under management. This cutting should remove trees of poor vigor, form, and species not to exceed fifty per cent of the gross volume. Highly defective trees should be felled and the resulting slash piled and burned. Logging slash should be lopped and scattered where thin, and piled and burned where accumulations occur.

Cutting practices in mature stands of poor vigor with a light potential ribes population will vary depending on the extent of defect in the mixed timber. If the mixed is largely sound the old seed tree method can be used because ribes are not a problem. Logging slash should be piled and burned. However, if the mixed is defective, all the merchantable timber should be logged, the defective material felled, and the area broadcast burned. This should be followed by planting to white pine.

In vigorous mature stands, relatively free of defective material and with a heavy potential ribes population, the immediate objectives of cutting are to maintain stand vigor as an insect control measure and to suppress ribes as an aid to blister rust control. Cutting should remove trees of poor vigor, form, and species, leaving an even canopy to cause suppression of ribes. From twenty-five to fifty per cent of the merchantable volume should be cut. A thrifty residual stand should be left which will be removed in one or more cuts after ribes have been suppressed and adequate reproduction of white pine has been obtained. Logging slash can be lopped and scattered where thin, and piled and burned where heavy, to reduce fire hazard. Defective trees should be felled where their removal will not break up the even canopy needed for ribes suppression, and the resulting slash piled and burned.

Stands similar to the foregoing but with highly defective mixed timber should be cut in a series of two or three partial cuttings, keeping the first cut light. After the final cutting the resulting slash and defective material should be disposed of by broadcast burning in one or two operations.

Low vigor stands of high ribes potential should be harvested in one or more cuttings depending on the defectiveness of the mixed timber. If the mixed timber is highly defective, one cutting may be necessary; if the mixed timber is sound, more cuttings can be made. Following removal of all merchantable material the area should be broadcast burned in one or two operations as previously mentioned and then planted to white pine after the area is determined to be free of ribes.

Overmature Stands

In overmature stands, usually over 200 years of age, the objective of cutting is to harvest merchantable values, rid the area of defective material, suppress ribes, and put the land back into production. Merchantable material may be removed in one or more cuttings. Logging slash and defective trees should be disposed of in one or two prescribed burns as previously described. White pine can be planted after the area is eradicated of any ribes which may germinate.

These briefly are the recommended cutting practices for stands of the white pine type. The recommendations for each particular kind of stand were determined by integrating protection from insects, disease, and fire with the silvical requirements of the species involved and finally deciding on a practice which appears to be economically sound. Some of the methods proposed need to be tested, especially partial cuttings and burning practices. The demands of protection are forcing us to adopt some practices which may complicate the growing of maximum amounts of Western white pine. However, this only proves how definitely protection is a part of white pine silviculture.

ZERO REFRIGERATION FOR THE FARM HOME

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INTRODUCTION

Home refrigeration has constituted one of the most important contributions toward raising the modern standard of living. It provides for better food preservation and a consequent improved and more healthful diet. The cost of home refrigeration is now considered not as an expense, but an economy, not only because of reduced food wastage, but also because of reduced hazard to health from food spoilage. But the temperature of 35 to 40 degrees commonly maintained in household electric refrigerators is suitable only for short time food storage such as a couple of weeks or a month.

For the preservation of foods for several months or as long as a year a much lower temperature is required to halt bacterial growth, and to reduce the activity of enzymes. The latter constitute what might be termed "ripening" agents which affect quality but do not in themselves cause decay.

While bacterial growth is largely halted at 15 to 20 degrees Fahrenheit, the activity of enzymes is not greatly retarded until the temperature is 10 to 15 degrees lower. The ideal long term storage temperature would be 15 to 30 degrees below zero except that such low temperatures are expensive to maintain.

Experience has shown that a satisfactory storage temperature for preserving meat, fruit, and vegetables in the home ranges from 5 degrees above to 5 degrees below zero. This temperature range is commonly referred to as zero refrigeration.

The freezing of meat, fruit, and vegetables preserves them for future use without the necessity for canning and this fact has contributed greatly to i popular acceptance. The economy buying perishable produce at a lo market price for use throughout tl year has been the reason for the rap and continued growth of this type business.

During the period 1930 to 1936, cer tral locker plants came into very ger eral use for zero storage, the cliente including both city dwellers and rur dwellers as well. However, for tl rural dweller living 10 to 15 miles fro the central locker plant, the need fc special trips to the locker made th cost of such storage almost prohibitiv Therefore, for such rural dwellers small, individual zero locker, locate on the farm would not only be mor accessible and could be used to bette advantage but it also would be mor economical to use. However, at th time, namely as late as 1936, there wer no small zero refrigeration plants o the farm.

In 1935-36, Washington State Colleg undertook the study of zero refrigera tion for rural users and thereby be came the pioneer investigator in thi field throughout the United States. Th State of Washington already had th honor of being the pioneer in centra locker development at Chehalis, an thus it was fitting that the individua zero locker should be pioneered in th same State.

The problem of zero refrigeration fo the home has not called for any larg amount of basic research in the fiel of refrigeration. Rather it has involve an extended study of home require ments as well as the solving of the following problems of engineering design 1. Desirable physical size of storag space for average family use. 2. Relative