RESEARCH IN FORESTRY
AND FOREST PRODUCTS

IN THE

GOVERNMENT   FOREST
EXPERIMENT   STATION

AND

OTHER PUBLIC RESEARCH ESTABLISHMENTS

IN

JAPAN

GOVERNMENT FOREST EXPERIMENT STATION

1958

N O T E

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recently to Food and Agricultural organization of
the United Nations for the publication "Research in
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of the Oxford system of decimal classification for
forestry, the classification does not coincide with
our classification of research divisions of the
Government Forest Experiment Station and other pub-
lic research establishments in this country.

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Introduction

Japanese forestry stands on the basis of her forests with an area of 24,998 hectares, 67% of the total area of the nation with five million forest owners of all kinds. However, the growing stock and growth in this county are not enough to meet the increasing demand for timber, so that with the remarkable increase of population and demand for wood that presumably will be followed by the growth of Japanese economy in the coming years, it is evident that an unbalance between the demand and supply structure of timber will produce a serious problem. Under these circumstances it is of paramount importance to elevate in the forest policy of Japan the productivity of forest land in every kind of forest, whether it may be a national forest, private or public one.

In order to carry out these tasks, the following policies are put into practice; they comprise:

a) Development of as large an area of inaccessible overmatured natural forests as possible to convert them to artificial forests with high productivity

b) Development of forest tree-breeding to increase land productivity and the economy of forestry, and

c) Promotion of soil conservation on an economic basis in accessible forests to be developed.

Along with them, encouragement of progress of economy in forest regions by improvement of management of private forests, and as the third step, rational utilization and development of new uses of wood must be taken up.

It is under these conditions that research activities are being conducted in the field of forestry and forest products, and every effort is being made in this country to conduct essential research to fulfil the above-mentioned missions.

The nucleus of these activities is the Government Forest Experiment Station which has with technically trained 228 research staff members as of 1957, seven branch stations located in such areas as are important from the viewpoint of forestry.

These local stations are conducting practical research to work out problems urgent in their regions under the guidance of the central station at Meguro, Tokyo.

In the central station we have an integrated research organization covering every field of forestry and forest products, especially in the latter consolidated research has been pushed forward. This station has been playing a leading role also in the technical progress of research activities in the prefectural experiment stations which as of 1957 have 370 technically trained personnel on their research staffs aiming to improve production of forestry there.

In the following table are given the names of the Government and Prefectural Forest Experiment Stations with their location.

A. Ministry of Agriculture and Forestry

(3.1) Koma Sub-Branch Station, Iwate

1. Central Forest Experiment Station

(1.1) Kiso Sub-Branch Station, Fukushima, Nagano

(1.2) Central Forest Genetics Institute, Mito

(1.3) Hokkaido Forest Genetics Experiment Station, Ebetsu

(1.4) Kyushu Forest Genetics Experiment Station, Kumamoto

(1.5) Tohoku Forest Genetics Experiment Station, Iwate

(1.6) Kansai Forest Genetics Experiment Station, Okayama

2. Hokkaido Branch Station

3. Aomori Branch Station, Aomori

4. Akita Branch Station, Akita

(4.1) Kamabuchi Sub-Branch Station, Yamagata

5. Kyoto Branch Station, Kyoto

(5.1) Takashima Sub-Branch Station, Okayama

6. Kochi Branch Station, Kochi

7. Kumamoto Branch Station, Kumamoto

8. Investigation Section, Forestry Agency

B. Prefectural Stations

9. Hokkaido Prefectural Forestry Guidance Station, Asahikawa, Hokkaido

10. Iwate Prefectural Forest Experiment Station, Iwate

11. Miyagi Prefectural Agricultural Experiment Station, Forest Division Miyagi

12. Akita Prefectural Forest Experiment Station, Akita

13. Fukushima Prefectural Forestry Guidance Station, Fukushima

14. Ibaragi Prefectural Forest Management Guidance Station, Ibaragi

15. Tochigi Prefectural Forestry Guidance Station, Tochigi

16. Gumma Prefectural Forest Experiment Station, Gumma

17. Chiba Prefectural Forestry Technique Guidance Station, Chiba

18. Kanagawa Prefectural Forestry Guidance Station, Kanagawa

19. Niigata Prefectural Forest Experiment Station, Niigata

20. Toyama Prefectural Agricultural Experiment Station, Fukuzawa Agriculture and Forestry Training Branch Station, Toyama

21. Ishikawa Prefectural Forest Experiment Station, Ishikawa

22. Fukui Prefectural Forestry Guidance Station, Fukui

23. Yamanashi Prefectural Forest Experiment Station, Yamanashi

24. Yamanashi Prefectural Wood Industry Guidance Station, Yamanashi

25. Gifu Prefectural Forest Experiment Station, Gifu

26. Shizuoka Prefectural Forest Experiment Station, Shizuoka

27. Aichi Prefectural Forest Experiment Station, Aichi

28. Kyoto Prefectural Forestry Guidance Station, Kyoto

29. Hyogo Prefectural Forest Experiment Station, Hyogo

30. Wakayama Prefectural Forest Experiment Station, Wakayama

31. Tottori Prefectural Forest Experiment Station, Tottori

32. Shimane Prefectural Forest Experiment Station, Shimane

33. Okayama Prefectural Forest Experiment Station, Okayama

34. Hiroshima Prefectural Forest Experiment Station, Hiroshima

35. Yamaguchi Prefectural Forest Experiment Station, Yamaguchi

36. Tokushima Prefectural Forestry Guidance Station, Tokushima

37. Kagawa Prefectural Forestry Guidance Station, Kagawa

38. Ehime Prefectural Forestry Guidance Station, Ehime

39. Kochi Prefectural Forestry Guidance Station, Kochi

40. Fukuoka Prefectural Forest Experiment Station, Fukuoka

41. Saga Prefectural Forest Experiment Station, Saga

42. Oita Prefectural Forest Experiment Station, Oita

43. Kagoshima Prefectural Forest Experiment Station, Kagoshima

I. FACTORS OF THE ENVIRONMENTS, BIOLOGY

A. Site Factors

1. Soil Relations

   a) Soil Formation -- To study soil types of such as brown, podsol, reddish soil and black soil (not Chernosom) in relation to their formation, distribution, characteristics and sub-division. (1)(2)

   b) Soil Physics

      i) Soil water -- To determine permeability, water-retaining capacity (pF-curves) of undisturbed soil, hysterisis of pF-curve of each soil type and swelling. (1)

      ii) Structure -- To determine classification of soil structures and their proportions in relation to water contents and permeability, as well as to study determination by the micropedological method. (1)

   c) Humus -- To determine morphological classification and chemical properties. (1)(2)

   d) Productivity of Forest Soil

      i) Soil productivity -- To determine soil productivity of various important native species in relation to tree growth and soil factors such as permeability, pF-curve, volume weight, acidity, C/N-ratio and others. (1)(2)(7)

   e) Soil Survey

      i) Soil map -- mapping of soil distribution has been carried out in (1)(2)(6) and (7).

      ii) Air photo -- application of air-photo has been made to conduct soil survey. (1)

2. Climatic Relations

   a) Forest Climate -- To measure and analyze soil and air

temperatures, precipitation, wind movement, snow
deposit, evaporation and other factors in relation
to the types of vegetation. (1)

3. Soil and Water Conservation and Erosion Control

a) Effects of Vegetation on Forest Hydrology -- To
investigate the effects of various types of vegeta-
tion under natural and controlled conditions upon
evaporation, transpiration, infiltration, run-off,
storage and distribution of snow and stream-flow in
mountain areas, and to develop methods of improving
and managing such areas in question for the protec-
tion and benefit of downstream communities. (1)(3.1)
(4.1)(5.1)(7.1)

b) Influences of Forest on Erosion -- To analyse the
mechanism of soil erosion by water, wind, avalanche,
soil freezing on mountain areas in relation to various
forests and forestry practices and related land uses,
and local wind erosion on the coast or inland as a
means of arranging practical methods of erosion control.
(1)(3.1)(31)

c) Flood Control -- To determine extent, nature and cause
of flood problems and kind, cost and benefits of meas-
ures needed to be applied for the control of peak flow
and landslips on watershed lands. (1)(4.1)(5.1)

d) Practical Erosion Control -- To evaluate the effects
of various preventive works against soil erosion and
avalanche beyond the conservational ability of forest,
and to interpret the results in terms of forest engine-
ering problems and their solution. (1)

B. Animal Ecology

1. Higher Forest Animals

a) Livestock Relationships -- To determine an efficient
basis for grazing in natural and artificial forests by
livestock. (1)(2)

C. General and Systematic Botany

1. Plant Physiology -- As a fundamental base of biochemical
genetics, the relationship of species and varieties is
observed by their chemical constituents of woods, to
determine foundamental metabolism of higher plants,
especially metabolic path of shikimic acid from carbon-
hydrate to lignin or other C_6-C_3-C_6 compounds. (1)

2. Genetics

a) Identification of Geographic Strains: To show whether
or not distinct geographic races are present within the
species such as Pinus densiflora, Pinus Thunbergii,
Cryptomeria japonica, and Larix leptolepsis, of which
three to six test plantations were established through-
out the country. (1)(1.1)(2)(3)(3.1)(4)(6)(7)

b) Individual Tree Selection

Selection for Rapid Growth, Form, Straight Stem, etc. --
To develop good strains or to preserve desirable breed-
ing materials, phenotypically superior trees of Crypt-
omeria japonica and other native species have been
selected, propagated by cutting or grafting and pre-
served in seed orchard or genetical arboretum. Progeny
testing will follow. All experiment stations.

Selection for Disease Resistance -- thirty Cryptomeria
seedlings that appear to be resistant to Cercospora
cryptomeria have been selected in the nursery, and
the artificial contamination test is being undertaken.

Twenty larch trees were selected for resistance to Phoma
Yano-Kubotae. The contamination test will follow (1).

c) Controlled Pollinations

Intraspecific pollinations -- To make controlled pollin-
ations of intraspecific pollination with pine or
Cryptomeria for better growth and form.

The projeny testing is carried out at (1)(1.1)(2)(3)
(3.1)(5)(6)(7).

Interspecific hybridizations -- To make interspecific hybridization between native and exotic species to find hybrid with better growth, form and disease resistance. (1)(1.1)(2)(3)(5)

3. Systematic Botany

a) Dendrology -- Compiliation of scientific and common names of native trees and shrubs finished.

   Correction of them on the basis of anatomical considerations and others are under way with investigation and the making of maps of natural distribution of Japanese important species (1).

D. Plant Ecology

1. Silvics

a) Silvics -- To make auto-ecological studies of important timber tree species with local silvicultural considerations such as

   (i) in Hokkaido district, physiological solution to increase resistance to cold (1)(2).

   (ii) in the snowy region, to strengthen tolerance against possible snow pressure. (1)(4)(4.1)(9)

   (iii) in the barren areas, to determine the relation between growth of trees and air-conditions of soil determining adaptability of trees to be planted. (1)(3)

2. Plant Sociology

a) Ecological survey of vegetation -- To determine the limit of artificial reforestation on an economic basis in high-land district of northern Japan. (3)

b) Relation between Ground Vegetation and Growth of Planted Trees -- To determine good indicators to discriminate suitable site for Cryptomeria japonica, Pinus densiflora, etc. (1)

c) Plant Succession in Typhoon Damaged Site -- To determine reforestation in natural forests in Hokkaido where large-scale wind damages took place. (2)

d) Root-system of Forest Vegetation -- To determine development of root-system of forest vegetation according to soil layers (1)

e) Nutrient Requirements -- To investigate uptake of nutrient by main tree species through water culture and sand culture in order to clarify inter-relationship of uptake of each nutrient (1)(2)(3.1)(4)(6)(7)

   Almost all prefectural experiment stations.

f) Root-nodules of forest trees -- To ascertain the structure of isolation and inoculation of nodule-forming fungi and bacteria such as leguminous and non-leguminous. (1)

g) Effect of mish-cultivation of nodule-bearing trees -- To test under various field conditions effect of mish-cultivation of nodule-bearing trees (3.1).

II. Silviculture

A. Silvicultural System

1. Composition of Stands -- To establish optimal system of silviculture in artificial forest under the constraints of the existing growth conditions at each stage, considering density of stand inventory with the aid of statistics and advanced mathematics. As the next step in this research, soil and race relations will be given consideration as further constraints in working out the mathematical formula applicable to it; the main species about which this research has been carried out under the guidance of the silvicultural division of the Central Forest Experiment Station in all the ministrial forest experiment stations cover Cryptomeria japonica, Pinus densiflora and Larix leptolepsis. These local stations collect data available for the research, and besides that, six experimental sites are established for this research.

The very motive that initiated this research was due to the fact that in the course of research in stand density represented by number of tree per hectare, important relations were discovered between stand density and growing stock which were recognized as available for working out optimal system of silviculture in artificial forests (1).

2. Regeneration and Formation of Stands.

    a) Form of Regeneration -- To determine silvicultural system of Pinus densiflora, experiments of belt shaped clear-cutting system have been carried out, changing time of cutting, and extent of cutting (3).

3. Natural Regeneration.

    a) Type of Stand Formation -- To discriminate stand formation by frequency of tree-groups with tiers of canopy. This research has been carried out since 1915 under the direction of the Silvicultural Division of the Central Forest Experiment Station in all the ministrial local stations with the cooperation of national forests. The same has been the case with the following researches in natural generation (1).

    b) Degree of Prospect for Generation -- To determine degree of prospect for regeneration which can indicate the extent of success and the need of operation to make it successful on the process of succession of species and transformation of stands that can be represented by type of stand formation by controlled method (1).

B. Tending of Stands and Trees

1. Thinning

    a) New Tree Classification -- To develop this for important tree species necessary for discriminating tree class with ease to be tended in forest stands. This research has been conducted since 1903, producing a large number of records under the guidance of the silvicultural Division of the Central Forest Experiment Station in all the ministrial stations. The same system has been conducted in the following research in tending of stands and trees (1).

    b) Thinning System -- To develop stand formation by removing trees marked by the above-mentioned classification (1).

    c) Intensity of the Opening of Stand Canopy -- To determine the ratio of trees to be thinned on the basis of ratios of basal areas (1).

    d) Recurrence Phase of Thinning -- To determine the optimal time interval between the successive thinnings. (1).

C. Artificial Regeneration and Formation of Stands

1. Artificial Reforestation:

    a) Seed Studies -- To study germinative physiology and thermoperiodicity of the important timber tree species. (1)

    b) Comparison between Direct Sowing and Planting -- To determine results on Pinus densiflora. (1)(3)(3.1)

c) Comparison between Several Root - Pruning Methods in the Transplanting -- To determine the optimal way in transplanting of seedlings of Pinus densiflora. (3)(3.1)

d) Planting of Particular Types of Land -- To determine the best species and methods for reforestation or afforestation on denuded land in the chain of erosion control problem. (1)(3)(5)(9)

2. Structure of Stands as Related to their Productivity

a) Structure of Artificial Forests -- To determine classification of forest stands of various economically important species in their artificial plantations with significant characteristics of density of plantings, length of rotation and thinning regime. (1)(1.1)(2)(3) (4)(5)(7)

D. Combination of Forestry with Pastoral Husbandry

1. Alternate Forestry and Agriculture -- To elevate living conditions of farmers through improving management of high forest and coppice as well as field crops. (1)

2. Control of Grazing

a) Grazing in natural and artificial forests -- To develop systems of grazing cattle and sheep in natural and artificial forests. (1)(2)(10)

b) Classification of Grazing Type -- To ascertain present situation of vegetation in the open ranges and forests where grazing and other utilizations are being conducted. (1)(2)

3. Revegetation of the Range

a) Season of Mowing -- To study the most suitable season to mow forage plants to assure improvement or maintenance of forage productivity. (1)

b) Intensity of Mowing and Vegetation -- To study the relation between intensity of mowing and vegetation of forage plants. (1)

4. Forage Plants

a) Life History -- To study the basis of improvement in grazing, fertilizing, irrigation, and control burning. (1)(2)

b) Tolerance of Forage Plants -- To study the variation of growth and other conditions through sun-shade grid according to forage plants which are influenced by the change of sun-light. (1)(17)(28)(29)

c) Growth and Weight of Forage Plants -- To study relation between height and weight of forage plants to determine the condition, class, and the capacity of range to support cattle. (1)(2)(12)(32)

5. Control of Undersirable Woody Plants

a) Removal of Noxious Woody Plants -- To discover the most suitable season to remove noxious range shrubs and to determine what procedures can be used in order to prevent further invasion. (1)

b) Conversion of Low Value Brushland to Productive Coppice and Grassland -- To study possible measures to maintain and improve land productivity by establishing a coppice for fertilizer purposes, which will be removed when the cutting age is reached, so that the cut-over land may be utilized as range land before it be converted to coppice once again. (1)(7)(15)(29)

III. FOREST INJURIES AND PROTECTION

A. Damage by Inorganic Agencies, especially by Fire

1. Storm, Drought, Snow and Frost

   a) Storm -- To investigate the relative durability of various kinds of trees and forests against typhoons in relation to topography, and subsequently to develop formation of stands having high durability against storm. (1)(43)

   b) Snow and Glazed Ice -- To analyze the significant elements about snow and glazed ice damages of planted trees and to study methods to restore the natural equilibrium as quickly as possible. (1)(29)

   c) Frost and Low Temperature -- To investigate the damage by frost and low temperature in relation to local topography at nursery and planting districts as a means of determining practical techniques to reduce the damage. (1)(22)

2. Control of Fire

   a) Prevention of Forest Fire -- To study the behavior of forest fires in relation to climatic factors and topography for the guidance of fire weather forecast and establishment of permanent firebreaks. (1)(2)

   b) Suppression Methods and Techniques -- To test the relative effectiveness of fire-fighting chemical materials against typical fuels experimentally for application on field fires. (1)(2)

B. Damages by Plant Organisms and their Control

1. Diseases Affecting Forest Stands.

   i. Analytical survey of predisposing factors of the various diseases -- To determine the control methods of sylvicultural practices for preventing various kinds of twig blights of Cryotomeria, needlecast of pines, needle blight of Chamaecyparis, shoe string disease of conifers, etc. (1)(4)(5)(6)(7)(10)(32)(40)(41)

   ii. Sylvicultural control of leat cast of larch: (1)(1.1)(2)(3)(4)

   a) Determination of soil conditions -- To determine the soil conditions in which the disease is most prevalent.

   b) Field and laboratory experiments -- To find out the nutritional condition of larch in relation to the occurrence of the disease.

   c) Etiological investigation of the causal organisms.

   d) Finding of resistant larch strains -- To select the resistant individuals from the heavily diseased stands.

   e) Determination of nature of resistance -- To ascertain the laboratorical method of determining the resistibility.

   iii. Control of heart rot damages of coniferous stands by forest management -- To investigate the occurrence of butt rot and stem rot diseases of coniferous forests in northern regions, the classification of the causal fungi, their distribution, their site relation, and to determine the forest management conducive to making free, or apt to escape from, their damages. (1)

2. Diseases of Trees for Special Purposes.

   i. Testing the disease resistant poplars -- To test the resistibility of native and exotic poplars against the rusts. (1)(4)

   ii. Selection and propagation of chestnuts resistant to the chestnut blight. (1)

   iii. General survey of diseases -- To make fundamental survey of diseases of bamboo and various kinds of trees for special purposes. (1)(5)

3. Forest Nursery Diseases and their Control

   i. Control of needle blight of Cryptomeria -- To determine the most effective kind of chemicals (both liquid and powder), the exact time for spraying, the selection of

spraying machine, etc.. (1)(4)(11)

ii. Cause and Control of snow blights of conifers, Crypto-
meria, pines, spruces and todo-fir -- To make etiological
and pathological studies of the diseases, and to test
chemicals for control purposes. (2)(4)(33)

iii. Damping off of coniferous seedling -- To study the
effect of the soil treatment with pyrolignous acid for the
control of damping off and its influence on the soil
microflora. (1)(3)(4)(19)(29)

C. Damages by Insects and their Control

1. Insect Injuries to Forests

i. Prediction of the abnormal outbreak of Japanese pine
moth and their control. (1)(1.1)(3)(4)(5)(6)(7)(30)(33)
(34)(40)(43)

a) General survey in various regions -- To estimate the
population density of the pine moth at 7 experimental
plots settled in various regions 5-6 times in a year
for 10 years.

b) Parasitic insects -- To make analytical studies of
parasitic insect eggs, larvae, pupae and adult.

c) Parasitic microbes -- To make analytical studies of
parasitism of Isaria farinosa and some virus, especial-
ly in the Central station.

d) Biotic potential of pine moth -- To analyse the yearly
variation of biotic potential of the pine month by
rearing in laboratory.

e) Methods of estimating population density -- To establish
practical criteria for judging the probable population
density of the insects for use in predicity of the
outbreaks.

ii. Barkbeetles and the control.

a) Taxonomy of barkbeetles and their allies.

b) Succession of barkbeetles -- To make ecological researches
on barkbeetles in Japanese red pine (plantations) forests,
and to deduce improved forest treatment for the control
of barkbeetle damage. (1)

c) Prevention of barkbeetles in injuries sustained in wind-
damaged forest areas -- To investigate the multiplication
of the barkbeetle population after wind damage in Ezo-
spruce and Todo-fir natural forests in Hokkaido, and to
find preventive measures against their propagation by
means of chemical spraying, salvage cutting, appropriate
treatment of fallen trunks, etc. (2)

iii. May beetles (Scarabaeideae) and their control -- To
prevent the injuries of May beetles in larch plantation. (1)
(1.1)

iv. Microlepidoptera and their control.

a) Ecological survey and control of Ezo-spruce budworm. (2)

b) Taxonomic studies on Microlepidoptera -- To make funda-
mental studies on these insects which are particularly
injurious to coniferous plantations. (5)(33)

v. Larch sawflies and their control.

a) Taxonomy and biology of larch sawflies -- To make funda-
mental studies on these insects which are very injurious
to larch plantations throughout the country. (1)(1.1)

vi. Aphids and their control.

a) Ecology and control of aphids -- To establish the sylvi-
cultural control methods for preventing the Aphids of
Todo-fir and gall aphids of Ezo-spruce, both injurious
to young plantations in Hokkaido. (2)

vii. Leaf beetles and their control.

Chemical control of leaf beetles of Cryptomeria -- To estab-
lish effective chemical control methods based upon the
ecological investigation of the leaf beetles that have been
carried out. (5)

viii. Gall midges of Cryptomeria and their control --

a) Fundamental studies -- To carry out fundamental biological studies upon a new gall midge, Thomasiniana odai, which attacks the bark of Cryptomeria in Kyūshū, causing the death of host plants in matured plantations, and to find out effective methods for their control. (7)

2. Nursery Insects and their Control.

i. Soil insects and their control -- To develop chemical controls of white grubs, Scepticus griseus and S. insularis. (1)(3)(33)

3. Biological Control of Insects.

a) Insect pathology -- To carry out fundamental studies on the pathology of forest insect-diseases, and to make a general survey of insect diseases in nature. (1)

D. Losses from Deterioration by Fungi and Insects between Cutting and Reaching the Mill, and their Control. (1)

i. Fundamental studies -- To study the taxonomy, ecology, physiology, distribution of blue staining fungi, wood rotting fungi and wood borers.

ii. Control -- To establish chemical control methods by spraying BHC and PCP solution on pine, spruce, fir, beech and birch logs.

E. Damages by Higher Animals

i. Control of wild mice -- To make synecological investigation of rats' fauna in the forest and neighbouring area, and to develop a practical method for the control by sylvicultural and also chemical counter-measures. (1)(2)

ii. Control of wild hares -- To carry out fundamental investigations on the ecology of wild hares. (1)(2)(34)

F. Insecticides and Fungicides

i. BHC airsol -- To develop fundamental knowledge on BHC airsol by laboratory experiments and to find out the most effective directions for its application to forest insect control. (1)(21)

ii. The behavior of chemicals sprayed on logs for their preservation. (1)

IV. MENSURATION, INCREMENT, YIELD

1. Forest Mathematics

   a) Statistical Methods -- To adapt techniques of advanced
   mathematical statistics (experimental design, sampling
   and time series analysis, work sampling, etc.) available
   for estimation of growth and stock. (1)

2. Yield in relation to Site, Tree Species and Silvicultural
   System

   a) Stand studies -- To prepare and improve yield tables
   for estimating volume of stand consisting of various
   species in different sites in every locality under
   various silvicultural systems, with the highly develop-
   ed statistical technique as basis for growth predic-
   tions to be used for national forest programming. A
   nationwide project has been carried on by all regional
   forest bureaus under the technical guidance of all ex-
   periment stations having more than 200 experimental
   sites. (1)(13)(29)(35)

   b) Aerial Survey -- To prepare as accurate a yield table
   as possible from aerial survey, which is applicable to
   sampling survey in cruising in as many states of stand
   as possible, with special attention to relationship
   between forest inventory and factors of interpretation
   of photo to be obtained from experimental sites locat-
   ed throughout the country. (1)

V. FOREST MANAGEMENT, BUSINESS ECONOMICS OF FORESTRY

1. Methods of Forest Management

   a) Management of National Forest -- To determine optimum
   method for the programming of management of national
   forest in order to promote the public welfare of the
   people when economical, silvicultural, and social
   factors are considered. To the application of linear
   programming and dynamic programming to this end special
   attention has been directed. (1)

   b) Methods of Private Forests -- To study appropriate
   methods of management of private forests classified by
   various factors in relation to forest owners' main
   business, especially farming, with the aim to elevate
   their standard of living by forest management. (1)(19)

   c) Technical Objects of Management -- To determine stand
   structure and growth by important native and exotic
   species and test the comparison of growth between them
   so as to yield maximum benefits under permanent manage-
   ment when economical, silvicultural, and social factors
   are considered, all the experiment stations.

2. Financial Aspects

   a) To develop basic appropriate methods of assessing forest
   property, methods of determining financial aspects of
   forest enterprises as going concerns. Special attention
   on appropriate methods of book-keeping. (1)(22)(29)(31)

   b) Forest Cooperatives -- To determine appropriate policy
   to develop organization of forest cooperatives.
   Special attention on historical development of the
   organization under the social and economic structure
   of Japanese forestry. (1)

VI. MARKETING OF FOREST PRODUCTS

a) Theory -- To study what order exists in the market structure of forest products, pay special attention to the behavior of those concerned with functions of the markets with the purpose of applying the results obtained to the actual forest policy. (1)

b) Price structure -- To develop the technique of predicting lumber price, making use of the information obtained from having analysed the price structure of timber and lumber markets. (1)

Work Studies

1. Efficiency of Forest Operation

a) Labour operation -- To determine relative metabolic rate of all kinds of forest operation as well as consequent fatigues by flicker value in order to improve efficiency of labour operation. (1)

b) Operation Standard -- To determine optimum standard progress of motion and scope rate in forest operations, and to improve tools used in them. (1)

2. Forest Machines

a) Sky-rope transportation -- To clarify relations between conditions of cable and allowable load, studying tension for the main cable and operating rope of a skidder and efficiency of engine, and devising a wirerope tension tester which will be available for measuring tension more accurately.

b) Truck Transportation -- To study pull power, fuel consumption, vibration and acceleration of truck used for logging. (1)

c) Railway transportation -- To study resistence of train in motion and brake of a train used for logging. (1)

VII. FOREST PRODUCTS AND THEIR UTILIZATION

A. Wood and Bark. Structure and Properties.

1. Structure and Identification of Woods.

a) Cell Wall Structure -- To investigate, by means of electromicroscopic method, the basic knowledge on wood technology. (1)

b) Identification -- To describe anatomical structure of domestic and imported woods; to arrange key for identification of domestic and imported wood by means of microscope, and card sorting key with respect to providing a simple means for the identification of them. (1)

2. Physical and Mechanical Properties of Woods.

a) Physical Properties -- To study the electrical properties of dielectric constant and resistivity in relation to the measurement of moisture content including use of moisture meters; to study the drying stress in wood to determine the conditioning of temperature and relative humidity for the stress relief and the moisture movement through wood in relation to the seasoning; to study shrinkage, swelling and thermal properties of wood and wooden product materials such as the fiberboard and particle board. (1)(30)

b) Strength Properties -- To determine the basic strength and the nine elastic constants of clear wood specimens as a guide for the use of various species grown in Japan, by means of the Japanese Standard Testing Methods (JIS. A1001-1012). (1)

c) Testing Methods -- To investigate and develop the testing methods for the determination of the strength in bending, in shear and in cleavage, and of the rigidity moduli in torsion of clear specimens; to determine the testing methods for physical properties, such as water and vapor absorption, thermal conductivity, thermal plasticity, electrical resistance and others. (1)

4. Growth Conditions and Wood Quality.

a) Relationship between Silvicultural Treatment and Properties -- To determine the effect of silviculture on properties of timber; to study the variation of wood structure and their relationship to wood quality; to study the distribution of branch and other defects and their effect on lumber quality. (1)

b) Classification of Wood Quality -- To investigate the relationship of the construction of annual rings to the bulk density and other properties of wood; to determine the most stable class of wood quality on each tree species. (1)

B. Conversion. Wood Working Industries and Products.

1. Wood Working Machinery.

a) Timber Conversion -- To study the relation between quality of log and sawed timber grade. To investigate shape, size and distribution of knots in silvicultured coniferous log. (1)(23)

b) Sawing Method --- To test the relation of cutting factors to efficiency in mitre saw, heat generation of circular saw tooth, and the effects of band saw guides on sawing efficiency. (1)(9)(12)(24)

c) Cutting with planer -- To study the relation between quality of work and cutting conditions for various species on planing, and to study spindle cutter and scarf cutter. (1)

d) Cutting with Shaving Machine -- To study the factors affecting cutting chip by the shaving machine in relation to the properties of particle boards. (1)(9)(12)

3. Wood Finishing.

a) Properties of Coatings -- To determine the adhesion of various coatings using the accelerated weathering test. (1)(12)(24)

b) Under Coating Methods -- To determine the relation of various wood species, kinds of paper, resin content and coating properties in paper overlaid on plywood; to

establish procedures of end coating. (1)

4. Glues, Gluing and Veneer Manufacture.

a) Manufacture of Synthetic Resin Adhesives -- To prepare manufacturing process of synthetic resin adhesive (urea formaldehyde resin, melamin formaldehyde resin, phenol formaldehyde resin), including factors of mol ratio, catalyst, heating and pH conditions; to determine components of rabeled synthetic resin adhesive with Radio Isotope by means of paper chromatography. (1)

b) Mechanism and Nature of Adhesion -- To conduct research on the relationship between Van der Waal's force, anchoring force and chemical bonding; to test the gluing properties of various species and adhesives; to investigate the real adhesive strength and conditions of adhesion. (1)

c) Improvement of Plywood Manufacturing and its Properties -- To study factors involved in producing no void, no overlap plywood, no clamped plywood, resin sheets overlaid plywood, sliced veneer overlaid plywood and lumber core plywood; to test the strength and bonding properties of these plywood; to improve the edge-gluing of rotary cut and sliced veneer by the tapeless splicer and the edge gluer; to determined the conditions of edge-gluing of strips (lumber core plywood), such as curing temperature, period of curing, pH of adhesive; to study relationship between construction (thickness width of strips, face and cross band veneer, wood species, moisture contents) and warp, waves on surface. (1)(9)(12)

d) Veneer Manufacture -- To study the effect of knife and nose-bar setting, knife angle, micro-bevel of knife edge, shape of nose-bar edge, and heating of logs on the quality of veneer cut with rotary lathe and slicer on various species, including small diameter logs. (1)(9)(12)

e) Drying of Veneer -- To study the veneer drying rates and various factors affecting drying veneer, such as temperature, air velocity, etc.; to study the shrinkage, development of defects during drying of veneer and the method to control them; to study the fundamental data to design the mechanical dryer most

suitable for various thicknesses of veneer and to find out the most suitable schedule for veneer drying. (1)

7. Structural Utilization of Wood.

a) Standard Specifications of Laminated Wood -- To prepare standard specifications as to design and fabrication of laminated wood; to investigate the safe bending radius of lamination for curved laminated wood; to test efficiency of plain scarf joint for its strength properties; to make scarfing by scarf cutter. (1)

b) Strength Properties -- To investigate strength properties of straight and curved laminated wood; to presume the bending qualities from the initial strength of lumber used. (1)

c) Adhesion and Adhesives for Laminated Wood -- To prepare adhesives adapted for laminating operation; to test the suitability of glue for interior or exterior laminated wood. (1)

C. Preservation and Other Treatments to Improve the Properties of Wood.

1. Seasoning of Wood.

a) Dry Kilns -- To study air circulation, uniformity of temperature and drying rate of boards in the dry kiln of internal fan type, and the conditions to dry boards in the dry kiln of small furnace type. (1)(9)(12)(24)

b) Operation of Wood Drying -- To study the drying rate of board in various temperatures and relative humidities in a constant air velocity, to determine drying schedules for Japanese beech and oak in the kiln of internal fan type. (1)(9)(24)

2. Protection of Wood from Fire.

a) Flammability Test -- To determine the flammability of untreated wood and wood treated with various fire retardants and others. (1)

b) Fire Retardant Treatment -- To investigate procedures

of fire retardent treatment with chemicals for wood, plywood and fiberboard. (1)(9)

c) Fire Test -- To establish fire test procedures and defining performance standards for building construction materials. (1)

3. Wood Preservation.

a) Preservative Tests on Small Blocks -- To test the effectiveness of various preservatives over a range of concentrations by means of wood block testing method (the medium for growing fungi is saw-dust); to determine the weathering method for testing the effectiveness of preservatives. (1)

b) Wood Preservatives -- To compare the toxicity and permanence of various water borne preservatives by laboratory tests and field tests. (1)(9)

c) Durability of Various Species -- To test the durability by means of wood block test (fungi grown in the medium of saw-dust.) in the laboratory. (1)

d) Stake Test -- To test the effectiveness of various preservatives and the durability of various species of wood with stakes in the field. (1)

e) Wood Preserving Process -- To determine treatability of various timbers and study factors affecting pressure penetration of oil and water-borne preservatives; to determine treating conditions of hot-and-cold bath process, Boulton process, stream-and vacuum process and diffusion process. (1)

D. Pulp Industries. Chemical Utilization of Wood.

1. Wood Waste Utilization. Fiberboards and Wood Particle Board. Board.

a) Fiber-base Materials -- To evaluate Japanese wood and bamboo as fiber-base material in technical researches, such as the pulping, forming, the mechanical and physical properties of boards. (1)

b) Processing and Equipment -- To study the preparation of particles, drying of particles, the effect of hot-pressing, the binder for particle board, and the manufacturing equipment to meet our present situation relating to resources and economical factors. (1)

2. Yield and Quality of Pulp.

a) Improving High Yield Pulping -- To study the kinetic mechanism in neutral sodium sulphite pulping and the quick cooking using Asplund Defibrator. (1)

3. Use of Inferior Species.

a) Hardwood and Special Softwood for Pulp and Paper -- To increase the utilization of hardwood comparatively abundant in existing Japanese cedar, and Japanese larch; those will become abundant for the future. (1)

4. Chemistry of Wood, Bark and Cellulose.

a) Chemistry of Bark -- To obtain fundamental knowledge on the chemistry of bark with the objective of developing valuable uses for this. (1)

b) Chemistry of Wood -- To obtain fundamental knowledge on the durability of wood from the view point of its extractive substances. (1)

c) Destructive Distillation of Wood -- To study the method of making charcoal, especially in a portable continuous carbonization kiln, to study properties of the charcoal produced for industrial uses, to study the properties of wood vinegar, especially the phenolic compounds dissolved in vinegar. (1)

5. Hydrolysis and Lignin.

a) Special Wood-Hydrolysis and Process Studies -- To investigate improved prehydrolysis and hydrolysis method for conversion of pentose to furfural and hexose to levulinic acid. (1)(9)

b) Hydrogenation of Lignin and Wood. (reaction with hydrogen has under heat and pressure) -- To investigate hydrogenation on various type of lignin and wood, using various catalysts and conditions, and characterize the

resulting products. (1)(9)

c) Chemistry of Lignin -- To study chemical accessibility of coniferous protolignin on pulping digestion. (1)

6. Physical Chemistry of Wood.

a) Study of the Mechanisms of Penetration, Adsorption and Diffusion in and through Wood -- To investigate the penetration rate of swelling or non-swelling liquid into evacuated wood, and to determine the diffusion constants of liquid vapors through the cell wall of wood, and their concentration dependence. (1)

b) Study of Thermoplastic Properties of Wood -- To investigate the compressive deformation rate of wood under high temperatures and the stress relaxation time, using a plastometer in an autoclave. (1)

c) Study of the Sorption and Desorption Behaviour of Wood to Water-Vapor -- To investigate the heat of wetting of wood by some organic liquids and its relation to hydrogen-bond formation. (1)

d) Study of Chemical Reaction in the Cell Wall of Wood -- To develop means of stabilizing dimensions of wood to study the accessibility of wood substance by some organic metal-compounds. (1)

E.   Other Forest Products

1. Pine Gum, Turpentine, and Other Resinous Products (Naval Stores, Oils).

a) Extraction, Flow, and Yield.

(i) Gum Yields -- To develop a practical method of turpentining on Pinus densiflora under economical condition to produce gum in excellent yield and to promote forest management practice. (1)

b) Equipment, Methods of Production, and Derivatives.

(i) Composition of Acidic Portion of Pine Gum -- To determine the composition of resin acids in

leoresin of pinus densiflora and confirm the chemic-
al nature of some new resin acid to improve the
practical uses of resin or rosin. (1)

(ii) Composition of Neutral Portion of Pine Gum -- To
obtain the composition of higher boiling point
neutral portion of oleoresin of pinus densiflora
to find its practical uses or to improve the
quality of rosin. (1)

c) Cultivation of edible Mushroom -- To determine appro-
priate method of cultivating edible mushrooms and to
give technical assistance to those mushroom growers,
making use of logs of the deciduous-oak species. In
(1), and almost all prefectural stations.

VIII. FORESTS AND FORESTRY FROM THE NATIONAL
VIEW POINT, SOCIAL ECONOMICS OF FORESTRY

A. Forest Survey and Forest and Range
Resource Analysis

Forest survey has been concentrated to clarify, first of
all, economic, and secondly, social aspects of the so-called
forest regions in order to determine their importance to the
economic development of local industries and communities.

a) Utilization of Forest -- To estimate grazing and forest
management in forests of all ownerships
according to system of forest treatments.

b) Labour Conditions -- To estimate wages, working conditions
and efficiency in forests of all owner-
ships in connection with economic and
social situations.

c) Marketing Conditions of Forest Products -- To estimate the
present and the probable future utiliza-
tion factors of forest products.

d) Utilization of National Forest by Rural Community -- To
estimate historical, economic and social
connections between national forest and
rural communities concerned, as applying
to the utilization of products from the
national forests.

e) Forest Finance -- To estimate basic conditions of the cur-
rent system in forest finance.

f) Price Reporting Service -- To estimate in cooperation with
other agencies the present basic price
data for sawlogs, lumber, poles, posts
and other forest products.

g) Other statistics - To estimate the current trend in forest
cooperatives, huntings and wild life
management, forest fire insurance oper-
ated by the state, the area, location,
kind and ownership of all forest lands
and the quality and quantity of timber

on forest land, as well as labour condi-
tions and forest production. Annual
survey to keep the results up to date.

h) Publication of Findings -- To estimate the forest survey
results available for private and public
uses, statistics and analytical reports
are prepared by (8) and other sections
of the Forestry Agency.

B. Laws and Governmental Interventions

Effect of Forest Laws -- To study the effect of the
forest laws which have been put into effect since 1952, con-
trolling forest regulation throughout the nation. Along with
it intensive research has been conducted to work out a more
effective forest policy, studying forest laws of foreign
countries existing in the past and at present, relationship
between the laws and local communities, and measurement of
effect of the laws.