ORGANIZATION AND PROGRAM PLANNING FOR FOREST RESEARCH IN THAILAND

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I. BRIEF HISTORY

Though the practice of forestry in Thailand may be said to have originated as early as 1896, with the establishment of the Royal Forest Department, by order of King Chulalongkorn the Great or Rama V, forest research has made very slow progress even up to the present. In the early days, the Royal Forest Department was manned by a very small staff of British forest officers, loaned from the Forest Services of India and Burma and these officers were mostly occupied with routine duty of inspection, administration and looking after the national forests. So it was no small wonder that at that time, forest research should be relegated to the background. However, the need to learn more about the forests that were being administered and more particularly the species of timber trees that made up the components of such forests, kindled a keen desire in some of these forest officers to conduct botanical survey and research into the flora of the country, concurrently with their other duties.

W.F. Lloyd, the Chief Conservator of Forests of that time, started a botanical survey of the indigenous economic plants as early as 1907. He enlisted the help of Sir W.W. Smith, then Curator of the Herbarium at Calcutta and Captain A.T. Gage, Superintendent of the Royal Botanic Garden, Calcutta, in the identification of specimens sent from Thailand. W.G. Craib, who came to work temporarily at the Calcutta Botanical Garden in 1908 and later returned to continue his work at Kew, and at Aberdeen University, Scotland, contributed much of his time, working on the flora of Thailand, even up to the time of his death in 1934. His monumental work, the Florae Siamensis Enumeratio, is still uncompleted at the time of his demise.

When Thai officers came to join the staff of the Royal Forest Department from 1903 onwards, many of them kept up this keen interest in carrying on research into the flora of the country. Outstanding among these officers, may be mentioned Phya Vanpruks Picharn. F.L.S., Phya Winit Wanadorn, Khid Suvarnasuddhi and Tem Smitinanda, F. L. S.

Another British officer, serving with the Thai Forest Service, who had made his name well-known in botanical circle, is H.B.G. Garrett. Garrett was mainly responsible in arranging with Sir David Prain, Superinten-

dent of the Royal Botanical Garden, Kew. to transfer the work of identification of Thai herbarium specimens from the Royal Botanic Garden, Calcutta, to Kew in 1910.

Later on when Khid Suvarnasuddhi took charge of the Royal Forest Department's botanical survey in 1935, he widened the scope of this work by arranging for exchange and identification of specimens with other herbaria at Paris, London, Edinburgh, Leiden, Kepong, Singapore, Calcutta, Dehra Dun, and the Arnold Arboretum of New York, U.S.A. and this work is continuing up to the present.

Meanwhile, interests in research into other aspects of forestry had not been lacking, though there existed no central organization for directing and co-ordinating of forest research at that time. Many territorial forest officers conducted researches on the growth, regeneration and silvical characteristics of many of the more important timber and fuelwood species, on their own time and at their own inclination. However, lack of continuity in following up research programs and loss of vital statistics already collected by the above-mentioned forest researchers, are mainly responsible for the paucity of silvicultural knowledge, existing at present.

Experiment in teak planting was started by Phya Vanpruks Picharn in Pre, Northern Thailand, as early as 1906 and later on R.S. Burke Borrows made some studies into the growth and development of teak in the natural forests. Other officers, Particularly Phya Vanpruks Picharn and Laung Samarn Wanakich, took up studies on the increment of species lacking in annual growth ring, such as *Alstonia macrophylla* Wall., *Anisoptera* spp., *Calophyllum floribundum* Hk.f., *Cinnamomum partheroxylon* Meissn., *Cotelelobium lanceolatum* Craib., *Dipterocarpus* spp., *Dolichandrone serrulata* Seem., *Fagraea fragrans* Roxb., *Mesua ferrea* Linn., *Peltophorum inerme* Llan., etc. Plots for studying the increment of mangrove species were also set up in many of the tidal forests in different parts of the conntry. Trial planting of *Afzelia bakeri* Prain., *Afzelia xylocarpa* Craib., *Alstonia macrophylla* Wall., *Cotelelobium lanceolatum* Craib., *Dalbergia cochinchinensis* Pierre., *Dipterocarpus alatus* Roxb., *Fragraea fragrans* Roxb., *Gmelina arborea* Roxb., *Pentacme siamensis* Kurz., *Pterocarpus macrocarpus* Kurz., *Shorea obtusa* Wall., *Sindora siamensis*, Teysm., *Xylia kerri* Craib & Hutch. and many other species, were started in the different territorial divisions, but unfortunately no continuous record of these plantings was kept and many of the experimental plots are now lost and can not now be traced.

On the forest utilization side, tests on the durability of most of the more important timber trees were carried out by the graveyard method, but the procedures in carrying out the tests were haphazard and the results obtained were not of much value statistically.

This state of affairs continued up to the year 1945 when the Divisions of silviculture and Forest Products Research were created to take charge of research in silviculture and forest products respectively.

Through the above agencies, the planning and execution of forest research were for the first time entrusted to a central authority. At first, progress in forest research was very slow and no special budget was allocated for

this very important work till 1953. Competent personnel for research was also lacking, so forestry research was mainly confined to the study of the raising and planting of teak and some of the more important industrial and fuelwood species such as, *Acacia catechu* Willd., *Aleurites montana* Wilson., *Bombax malabaricum* D.C., *Broussonetia papyrifera* Vent., *Casuarina equisetifolia* Linn., *Casuarina junghuniana* Miq. var. *Spondias mangifera* Willd., *Trewia nudiflora* Linn., and some of the eucalypts, especially *Eucalyptus citriodora* Hook.

At this time, however, locations for regional forest experimental stations and substations were examined and most of the stations were started, though at first on a very modest scale. Plots to study the increment of teak in the natural forests and plantations after thinning and improvement felling were also established. On the forest products side, research was carried out on the identification of forest trees and timber as well as on the mechanical and physical properties of wood of diferent species. The Division of Forest Products Research at that time did not possess any testing machine, so the mechanical testing of timber was carried out with the co-operation of the Faculty of Engineering of Chulalongkorn University, whilst research into the physical properties of wood was conducted with the help of the Department of Science.

After the Second World War, however, help began to arrive in various forms. Many research workers were awarded fellowships by FAO, ICA and through the British Council, the Danish Government and Colombo Plan for training abroad. Experts were also provided by FAO to advise on research in various fields. Equipments, especially for forest products research, such as a timber testing machine and one set of kiln-drying equipment were presented by ICA and one set of wood working machinery was given by the British Government, through the Colombo Plan. Other equipments, such as a wood preservation unit, a pilot plywood plant, and an Amsler Testing Machine were procured with the Forest Products Research Division own budget. The supply of equipments and personnel as stated above made it possible to open a modern and well-equipped forest products research laboratory for the first time in 1958.

II. PRESENT ORGANIZATION FOR FOREST RESEARCH

In Thailand research in the branches of forestry and forest products are conducted under separate divisions though under the same department and often without any collaboration at all, so each branch will be dealt with separately.

Authorities responsible for the conducting of research in forestry are: 1. The Forestry Research Section of the Division of Silviculture, Royal Forest Department and 2. The College of Forestry, Kasetsart University.

Whilst the authorities vested with the duty of conducting research on forest products are: 1. The Division of Forest Products Research of the Royal Forest Department and 2. The College of Forestry, Kasetsart University.

The above are all governmental organization. Forest research carried out by private industries is negligible and does not contribute much to the research knowledge of the country.

A. Forestry Research

Forestry Research is mainly carried out by the Forestry Research Section of the Division of Silviculture, Royal Forest Department. The section is composed of 3 main branches, documentation, statistical and experimental. It is responsible for the collection and documentation of all information on forestry and forestry research, development of research programs, analysing and summation of results from research projects and inspecting and directing research works carried out by the different forest experimental stations and territorial forest divisions.

Research in the field is mostly carried out by the 6 Regional Forest Experimental Stations, namely the Northern, North Eastern, Central, Eastern, South-Western and Southern Regional Forest Experimental Stations. These stations are mostly situated near large areas of plantations or adjacent to the natural forests and one of them, the Central Regional Experimental Station is also in charge of the country only botanical garden.

Besides the Regional Forest Experimental Stations, there are also 4 Sub-Stations dealing exclusively with the problem of reforestation of denuded watersheds. Three of these sub-stations are in Northern Thailand, namely the Doi Chieng Dao Watershed Station in Chiengmai Province, the Doi Tung Watershed Station in Chiengrai Province and the Doi Chang Watershed Station also of the same province. In Central Thailand, the only existing Watershed Station, is Muak Lhek, in Saraburi and Nakorn Rajasima Provinces. These watershed experimental stations are situated in areas where most of the watersheds have been disforested by shifting cultivation. Another station dealing with soil conservation was established with the help of the United Operation Mision (USOM) in Thailand, at Pak Chong, Nakorn Rajasima Province. This station carries out research in soil conservation of denuded hillsides, in that particular locality.

The College of Forestry, Kasetsart University, has taken up forestry research only very recently, i.e. about 1957, after the 3 years curriculum is extended to 5 years, leading to the granting of the bachelor degree of forestry to the graduates. The expanded curriculum makes it obligatory for the students to do some research as part of their fulfilment toward obtaining the bachelor degree. As the College does not have any forest of its own, its research program is mainly confined to short term studies in the fields, carried out by instructors and students, during their attendance at summer camps. With the instigation of the Advisory Staff of the Oregon State University and the provision of counterpart fund for research, during the last 3 years, however, the College of Forestry, has been able to initiate some long term research projects, such as the research into the erosion and run-off from burnt and unburnt plots in the natural teak forests and teak plantations and the identification of soil properties which may be significanty correlated with the growth of teak forests.

B. Forest Products Research

Research into the forest products of Thailand is mainly the responsibility of the Forest Products Research Division of the Royal Forest Department. This division is situated at the Royal Forest Department's

headquarters in Bangkok. It is internally sub-divided into :

1) *Section of Forest Botany and Zoology*
   a) Forest Botany.
   b) Forest Zoology and
   c) Forest Pathology (proposed)

2) *Section of Wood Technology*
   a) Timber Testing.
   b) Wood Seasoning.
   c) Minor Forest Products.
   d) Wood-working Machinery.
   e) Veneer and Plywood.
   f) Naval Stores and
   g) Lac Development.

3) *Section of Technical Information*
   a) Forest Library.
   b) Secretarial Office of the Division.

4) *Section of Wood Structure*
   a) Wood Structure.
   b) Photomicrography.

5) *Section of Wood Chemistry*
   a) Chemical Analysis.
   b) Paper and Wood Pulb.

6) *Section of Forest Extension*
   a) Extension Units.
   b) Photography and Cinematography.

The new Forest Products Laboratory which was opened in 1958, is now equipped with :

1) One Amsler Testing Machine.
2) One Baldwin Testing Machine.
3) One Impact Testing Machine (locally made).
4) One dry kiln.
5) One timber impregnation plant.
6) One pilot plant for veneer and plywood.
7) One oil-seed compressor.
8) One set of wood working machinery.
9) One fumigation chamber.

The Forest Herbarium which is housed in another building apart from the main Forest Products Laboratory, contains about 30,000 sheets of herbarium specimens.

At the Forestry College, Kasetsart University, forest products research is carried out mainly by the Department of Wood Technology and Forest Utilization. The College has 2 small laboratories ; one for wood technology and the other for wood-working machinery.

Besides the institutions mentioned above, some research is also carried out by a few other private and semi-governmental organizations in their particular fields, i.e. the Thai Plywood Company in Bangkok, the Shaving Board Company at Sri Raja, Cholburi Province and the Thai Paper Factory at Kanburi, Province.

III. CURRENT FOREST PROBLEMS

Forestry problems that await research in Thailand is tremendous and complex, but the more urgent problems that need current attention may be broadly classified.

A. Forestry and Silviculture Research

Soil

Project 1. Determination of soil texture, for stands of all qualities, including the optimum, of the following species ; the correlation of ground vegetation and regeneration of the key species concerned, both natural and artificial, where possible to the soil class, or soil category.

(1) *Adina cordifolia* Hook.f.
(2) *Afzelia bakeri* Prain.
(3) *Afzelia xylocarpa* Craib.
(4) *Amoora rohituka* W. & A.
(5) *Anisoptera glabra* King.
(6) *Balanocarpus heimii* King.
(7) *Bombax malabaricum* DC.
(8) *Cedrela toona* Roxb. ex Rottle.
(9) *Cotylelobium lanceolatum* Craib.
(10) *Dalbergia cochinchinensis* Pierre.
(11) *Dialium cochinchinense* Pierre.
(12) *Diospyros mollis* Griff.
(13) *Dipterocarpus alatus* Roxb.
(14) *Dipterocarpus costatus* Gaertn.f.
(15) *Dipterocarpus dyeri* Pierre.
(16) *Dipterocarpus grandiflorus* Blanco.
(17) *Dipterocarpus obtusifolius* Teysm.
(18) *Dipterocarpus tuberculatus* Roxb.
(19) *Dipterocarpus turbinatus* Gaertn.f.
(20) *Fagraea frageans* Roxb.
(21) *Gmelina arborea* Roxb.
(22) *Hydnocarpus* spp.
(23) *Hopea ferrea* Pierre.
(24) *Hopea odorata* Roxb.
(25) *Lagerstroemia calyculata* Kurz.
(26) *Lagerstroemia flos-reginae* Retz.
(27) *Mangifera coloneura* Kurz.
(28) *Melanorrhoea usitata* Wall.
(29) *Mesua ferrea* Linn.
(30) *Parashorea stellata* Kurz.
(31) *Pentacme siamensis* Kurz.
(32) *Pinus khasya* Royle.
(33) *Pinus merkusii* Jungh.
(34) *Pterocarpus macrocarpus* Kurz.
(35) *Quercus falconeri* Kurz.
(36) *Quercus junghuhnii* Miq.
(37) *Sandoricum indicum* Cav.
(38) *Shorea acuminata* Dyer.
(39) *Shorea curtisii* Dyer.
(40) *Shorea floribunda* Kurz.
(41) *Shorea leprosula* Miq.
(42) *Shorea macroptera* Dyer.
(43) *Shorea obtusa* Wall.
(44) *Shorea parvifolia* Dyer.
(45) *Sindora siamensis* Teysm.
(46) *Sterculia campanulata* Wall.
(47) *Sterculia lychnophora* Hance.
(48) *Swietenia macrophylla* King.
(49) *Tectona grandis* Linn.f.
(50) *Tetrameles nudiflora* R.Br.
(51) *Vitex pubescens* Vahl,
(52) *Xylia kerii* Craib & Hutch.

Climate

Project 2. Study of air and soil temperature and soil moisture in areas subjected to clearing for shifting cultivation and comparable adjoining forest counterpart, during the growing season. Light to be recorded. Also to determine the amounts and rates of precipitation in the two situations.

Project 3. Study of the correlation between the local climate and the growth of *Pinus merkusii* Jungh and *Pinus Khasya* Royle.

Conservation and Erosion Control

Project 4. Determination of the effect of vegetation and clearing land for shifting cultivation and burnt areas, from natural forests and plantations, if possible on five different degrees of slope, viz. gentle (5–10 degrees), medium (11–20 degrees), steep (21–30 degrees), very steep (31–45 degrees) and precipitous (46 degrees and over).

project 5. Determination of the extent and causes of torrents and measures for regulating fluctuations of stream flow.

Project 6. Determination of water yield from watersheds with different forest covers, soils

and degrees of slope in comparison with denuded watersheds of the same sites.

Plant Physiology

Project 7. Study of the growth of tissues and formation of branches and multiple leaders in *Tectona grandis* Linn.f. and *Dalbergia cochinchinesins* Pierre.

Project 8. Determination of the influence of extraction of oil and resin on flowering, quantity of seeds, increment and timber quality of *Dipterocarpus alatus* Roxb, *Pinus merkusii* Jungh. and *Pinus khasya* Royle.

Project 9. Study of the formation of heartwood in *Acacia catechu* Willd.

Project 10. Study of the transpiration in young plants of *Casuarina* spp. and determine possible means of reducing the rate of transpiration in dry weather.

Project 11. Determination of the optimal period of physiological drying of teak timber by cutting down the whole tree without prior girdling and letting it to lie intact with all branches and leaves, followed by coating of ends of logs obtained with a waterproofing material, and to compare results with girdled trees of comparable dimensions.

Genetics

Project 12. To determine if there are distinct races of teak in Thailand, localities where they occur and methods of their propagation to produce the identical strain.

Project 13. Study of the occurrence of black streaks in teak, whether this is due to soil, biological or genetic factors.

Project 14. Selection of superior strain of teak for fast growth, superior form and timber, through budding and grafting and by establishment of seed orchards

Project 15. Study site variations, with a view to discover superior races, if any of *Dalbergia cochinchinensis* Pierre., if necessary also by intra and inter specific crossings and selections and to discover adaptability to various soil and site conditions.

Project 16. Selection of trees of *Pinus merkusii* Jungh. and *Pinus khasya* Royle., with high resin yield and the raising of progeny from these for tests.

Project 17. Selection and breeding of *Casuarina equisetifolia* Linn. for form with straighter bole and less branchiness.

Systematic Botany

Project 18. To study the natural distribution and occurrence of Thai forest tree species.

Project 19. To continue to establish and maintain arboreta of indigenous and exotic species and to prepare descriptive booklets for distribution and exchange with similar international bodies.

Project 20. Collection of fruits and seeds of indigenous and exotic species for storage in transparent containers for reference tests of identity and authenticity.

Project 21. To draw up an illustrated key, based on vegetative characteristics, for the identification of bamboos found in Thailand.

Project 22. Study the morphology of juvenile forms of forest tree species and preparation of coloured drawings to scale of the various stages from germination to the establishment stage of their seedlings.

Silvics

Project 23. Determination, under the following heads, periods of flowering, fruiting, seed

production and germination of forest trees species, in the various regions of the country, and leaf shedding and appearance of new leaves for deciduous species.

(1) Beginning of new leafing.
(2) Completion of new leafing.
(3) Beginning of opening of flowers.
(4) Maximum flowering.
(5) End of flowering.
(6) First ripe fruits.
(7) Most or all fruits ripe.
(8) Beginning of falling of seeds or fruits.
(9) Most seeds or fruits fallen.
(10) All good seeds or fruits fallen,
(11) Commencement of leaf fall.
(12) Completion of leaf fall.

(For conifers)

(13) Commencement of elongation of terminal buds.
(14) Commencement of appearance of new green needles.
(15) Needles achieve full size.
(16) Commencement of shrivelling of old needles.
(17) Completion of shrivelling of old needles.

Rainfall, mean temperature and humidity figures should also be collected for each month and filed with the records. The dates should be continuous numbers from 1 to 365 days for the year, as subsequent tabulation and calculations are facilitated.

Project 24. Determination of the season fo the height growth for the 52 species in Project 1 and for the indigenous bamboos.

Project 25. Study of the site requirements and silvicultural characteristics of the 52 species of Project 1 and of *Aleurites* spp. and species of Eucalyptus and Casuarina grown in the country.

To record also herbaceous and other ground flora, to discover by collation plant indicators, if any, of these species.

Project 26. Study the development of the root system of juvenile and adult forms of forest tree species, and also of shrubs, herbs, creepers, grasses and bamboos, as opportunities offer, in natural and plantation areas.

Project 27. Determination of the water repuirements of Casuarina.

Project 28, Study recruitment and survival of seedlings in the tropical evergreen forests, especially Dipterocarpus spp.

Plant Sociology

Project 29. Typology. Study of all the forest types by means of ecological quadrats, in in relation to the system of management and historical development.

Project 30. Study the progress of secondary growth in abandoned areas of shifting cultivation and collation with the probable primary composition of the stand as revealed by the neighbouring forest type.

Project 31. Study of virgin forest areas and the march of vegetation, under the existing conditions.

Project 32. Study the origin and development of swamps, the fluctuations of water levels therein, and determining methods of improving the swamp and vegetatiou.

Harvest Cuttings

Project 33. Determination of the best method of cutting, with the help of statistically comparable permanent experimental plots laid out for the purpose, for the types and sub-types of forests met with, to ensure

regeneration of the key species to at least 75 percent of normal stocking.

The treatments to be tested may consist of selection cuttings, of light and or heavy intensity, other silvicultural systems and even clear fellings with natural or artificial regeneration.

Project 34. Study of the existing systems of harvest cuttings, to gauge the progress of the establishment of regeneration to the limit mentioned under the preceding project.

Project 35. Determination of the silvicultural management of the bamboo forest for the supply of pulping material to the mill at Kanchanaburi.

Intermediate Cuttings

Project 36. Determination of the optimal intensity and interval of thinnings to promote basal area and height increment in teak plantations.

Project 37. Compilation of a list of forest weed trees. The list should be given wide circulation for inviting suggestions to keep it up to–date.

Project 38. Determination of the means of eradicating or controlling *Eupatorium odoratum* Linn., *Imperata cylindrica* Beaur. and Lantana.

Project 39. Development of technique for most economically removing unmerchantable trees, mostly weed trees, by poisoning, girdling, etc. and to test the usefulness of cultural operations like sanitation cuttings, prunings, cleanings, etc.

Artificial Regeneration—Seed Studies

Project 40. Establishment of a central seed testing station, with proper equipment and qualified personnel, capable of execution the FAO certificate of origin, the FAO certificate of quality and the International Seed Analysis Certificate.

Project 41. Determination of the best time of seed collection of the indigenous and acclimatized forest tree species.

Project 42. Determination of the best medium for the storage of forest tree seeds for the various indigenous and exotic species.

Project 43. To test the germination of seeds of indigenous and exotic forest tree seeds.

Project 44. Determination of the seed weights of all indigenous species and of exotics under trial. The international standards require the weight of 1000 seeds.

Project 45. To test the effect of pre-treatment of seeds. In addition to the usual methods, the effect of low temperture treatment, before germination, may also be tested. Treatment of seed of species like Casuarina with gammixane may also be tested,

Project 46. Compilation of a list of seed orchards in suitable localities.

Artificial Regeneration – Nursery Practices.

Project 47. Determination of the standard medium for sowing.

Project 48. Determination of the optimum quantity of seed to sow per standand bed of say 10 m. × 1 m.

Project 49. Determination of the most suitable data for sowing seeds of each species of importance, in the nursery.

Project 50. Study of the effect of pricking out seedlings.

Project 51. Study of the effect of partially or wholly shading nursery stock.

Artificial Regeneration – Planting Studies.

Project 52. Comparison of the methods of planting, i, e., direct sowing, transplanting, stump planting or planting cuttings.

Project 53. Determination of the best data of planting in the field.

Project 54. Determination of the optimum planting distance in the field.

Project 55. Determination of siutable species for planting in various localities.

Project 56. Determination of the optimum method of planting for each species of importance in the open or under shade of known intensity.

Project 57. Determination of the most successful methods of introducing desirable species e. g. Pines, Eucalyptus, Acacias, Mahogany, and other species suitable for pulp, plywood, other forest industries and fuelwood.

Control of Grazing and Fire

Project 58. Compare closure and non-closure of areas under regeneration to grazing and fires.

Mensuration, Increment, Yield

Project 59. Compilation of standard and commercial volume tables for the 52 species mentioned in Project 1 and the following species of the mangrove forest i.e. *Bruguiera caryophylloides* Blume., *Bruguiera eriopetala* Wight., *Bruguiera gymnorhiza* Lam., *Bruguiera parviflora* W. & A., *Rhizophora conjugata* Kurz., *Rhizophora mucronata* Lamk.

Project 60. Compilation of stand and yield tables for the important species for which even-aged crops are available, as teak, mangroves, Casuarina, *Melaleuca leucadendron* Linn., *Pinus merkusii* Jungh. and *Pinus khasya* Royle.

Tree increment plots should also be laid out for as many of the 52 species of Project 1, as possible.

N.B. 55 of the 60 projects listed above had been recommended by Mr. Jagdamba Prasad, former Silviculturist of the Forest Research Institute and Colleges, Dehra Dun, India and former Development Officer, Timber, Ministry of Commerce and Industry, Government of India. Mr. J. Prasad was deputed by FAO in 1955 and 1956, to Thailand to advise and assist the Government of Thailand on all aspects of silvicultural research and on the development of a systematic and comprehensive silvicultural research program, with particular regard to practical problem of economic significance as related to the program.

B. Forest Products Research

Problems in forest products research are also numerous, but the following had been drawn up for current research.

Botany and Zoology

Project BZ. 1. Collection of herbarium specimens.

Project BZ. 2. Description and identification of all reserved trees.

Project BZ. 2.1. Reserved trees of all the 15 North Eastern Provinces.

Wood Structure

Project WS. 1. Macroscopic and microscopic studies and description of structure and general properties of timber.

Project WS. 1.1. Studies in the anatomical structure of reserved timbers of the 15 North Eastern Provinces.

Project WS. 2. Preparation of the macroscopic and microscopic card sorting keys for identification.

Project WS. 2.2. Keys for the reserved timbers of the 15 North Eastern Provinces.

Project WS. 3. Photomicrography.

Project WS. 3.1. Photomicrographs of reserved timber of the 15 North Eastern Provinces.

Project WS. 6. Collection of authentic specimens of wood samples.

Project WS. 6.1. Collection of authentic specimens from reserved timber of the 15 North Eastern Provinces.

Utilization

Project UZ. 2. Promotion of the use of secondary timber.

Project UZ. 2.1. Promotion of the use of the secondary species of the 15 North Eastern Provinces, that possess some specific properties suitable for in some wood-based industries.

Project UZ. 4. Studies in wood harvesting.

Project UZ. 4.1. Comparative studies of the economic problems on the advantages and disadvantages of the girdling and not girdling of teak

Project UZ. 4.2. Physical and chemical changes that result from the girdling of teak.

Project UZ. 5. Utilization of minor forest products.

Project UZ. 5.1. Improvement in the use of bamboos.

Project UZ. 5.2. Improvement in the use of rattan.

Project UZ. 5.3. Tannin extraction from various forest products.

Biochemistry

Project BC. 3. Paper pulp investigation including studies of the fibrelength of some 10 species.

Project BC. 4. Investigation into the physical and chemical properties of minor forest products.

Project BC. 4,1. Bamboos.

Project BC. 4.2. Rattan.

Project BC. 4.3. Tannin from various forest products.

Plywood and Composite Wood

Project PC. 3. Peeling technique primarily with regards to knife angle.

Project PC. 4. Studies in peeling qualties of about 10 species of Thai timber (if possible those from the North Eastern Provinces.)

Project PC. 5. Studies in the technique of making plywood and laminated wood; especially to determine platen temperature, optimum pressure and optimum amount of glue spreading to produce the best result.

Timber Seasoning

Project TS. 2. Investigation in to the kiln seasoning of common commercial timbers.

Project TS. 2.1. Determination of optimum schedule for use in kiln drying of some 10 species of common commercial timber, especially those from the North Eastern Provinces.

Project TS. 2.2. Determination of shrinkage in kiln-dried timber.

Project TS. 3. Air-seasoning properties of common commercial timbers.

Project TS. 3.1. Determination of shrinkage in air-dried timber.

Timber Mechanics

Project TM. 3. Mechanical and physical properties of Thai timber (small clear specimens).

Project TM. 3.1. Revision of the already existing records with the purpose of bringing the method of computation in line with the present day statistical method.

Project TM. 3.2. Further investigation into the mechanical properties of other lesser known species, especially of the North Eastern Provinces.

Project TM. 5. Investigation into the effects of knots and slope of grain on the strength of timber.

Project TM. 8. Comparative studies of the strenght of teak naturally grown and plantation grown.

Wood Preservation

Project WP. 1. Studies in various impregnation processes.

Project WP. 2. Impregnation of telegraph poles and sleepers.

Project WP. 4. Durability tests of treated and untreated timber (Grave Yard Method).

Project WP. 5. Determination of the relation between wood structure and its response to presentative treatment.

Wood Working and Wood Bending

Project WW. 1. Investigation into the working and finishing qualities of some 15 commercial timbers especially of the North Eastern Provinces.

Project WW. 1.1. Their planing qualities.

Project WW. 1.2. Their turning qualities.

Project WW. 2. Mill conversion studies.

Project WW 2.1. Determination of the best method of sawing logs of different defects, sizes and slopes so as to minimize waste.

Entomology and Mycology

Paoject EM. 1. Collection of entomological specimens and wood rotting fungi.

Project EM. 7. Studies in types of decays in Yarng and other timber structure.

Project EM. 9. Testing of insecticide and fungicides for treatment of infested timer.

Development of Lac Cultivation

Project LC. 1. Experiment in breeding lac insect on forest trees. Selection of strain.

Project LC. 2. Studies in the proper method of manufacturing seed lac.

IV. IMPLEMENTATION OF THE FOREST RESEARCH PROGRAM

Since the above forest research programs had been drawn up i. e. the forestry research program in 1956 and the forest products research program in 1957, change in research personnel, especially of the officers in charge of research, and inadequate allotment of fund for research purposes have slowed down considerably the progress in the implementation of forest research programs.

It is also disheartening to record the shift in policy from vigorously pursuing the research program in forestry as laid down by Mr. J. Prasad, the FAO expert, to one of slowing down activities and the placing of more emphasis on the planting of species whose silvical characteristics and requirements are but dimly known. Of the 55 forestry research projects recommended by Prasad, only 6 projects will be carried on

by the Royal Forest Department in 1962. These include studies in the introduction of exotic species, the planting techniques of about 30 indigenous species, seed studies of about 40 native species, studies in the natural regeneration of the more important species in the Dry Deciduous Dipterocarps forests, studies of the silvical characteristics of some important timber trees and studies of the pests and diseases of forest trees as well as the danger from forest fires.

In the meanwhile, the following research problem in forestry had been investigated by the Faculty of Forestry, Kasetsart University, during 1957–1960.

Factors of the Environment, Biology

114.0 Collection of forest soils and analysis of forest soils.

114.1 Nature of soil in some parts of Huey Thark teak plantation.

114.2 Relation of slope and depth of surface soil in Me Thark teak plantation (1960).

114.3 Survey of the registration of government lands of the various governmental agencies which had already been centrally registered.

Silviculture

231.0 Germination per cent of teak seeds of different sizes.

231.1 Comparison in the growth of teak seedlings planted in soil trom Deciduous Dipterocarps Forests (Nakorn Rajasima) and soil from teak forest (Lampang).

231.2 Germination per cent of teak seeds buried at different levels and comparison of height growth of seedlings germinated above.

231.3 Comparison in the growth of *Pinus khasya* Royle. seedlings planted in soil from its own habitat (Chiengmai) and soil from Deciduous Dipterocarps Forest (Nakorn Rajasima).

232.0 Experiments in the grafting of buds of *Casuarina junhuniana* Miq. var. to stocks of *Casuarina equisetifolia* Linn.

287.0 Study of the distribution of bamboos in Me Huad–Me Thark forests, Lampang.

287.1 Relations between teak and bamboos in Me Huad–Me Thark forest, Lampang.

Forest Mensuration

522.0 Percentage of error between measurement of height of *Shorea obtusa* Wall. and *Pentacme siamensis* Kurz. from aerial photographs and from actual measurement.

524.0 Percentage of error between measurement of volume of *Shorea obtusa* Wall. and *Pentacme siamensis* from aerial photographs and from actual measurement.

527.0 Form quotient of teak growing in different sites

54. Site quality of teak.

561.0 Relations between crown diameter and height and basal area of *Shorea obtusa* Wall., *Dipterocarpus alatus* Roxb.

561.1 Relations between crown diameter and height and basal area and volume of *Pentacme siamensis* Kurz.

561.2 Relations between volume and diameter of *Pentacme siamensis* Kurz.

561.3 Relations between volume and

diameter of *Dipterocarpus tuberculatus* Roxb.

561.4 Relations between volume and height and diameter of *Shorea obtusa* Wall. and *Pentacme siamensis* Kurz.

561.5 Relations between crown diameter and basal area and height of *Dipterocarpus* spp.

561.6 Relations between crown diameter and height and height and basal area of *Pentacme siamensis* Kurz.

561.7 Relations between crown diameter and height and basal area of *Pentacme siamensis* Kurz.

561.8 Relations between crown diameter and height and basal area aud volume of *Dipterocarpus tuberculatus* Roxb.

561.9 Relations between height and basal area and crown diameter of *Pentacme siamensis* Kurz.

561.10 Relations between height and diameter and crown diameter of *Dipterocarpus tuberculatus* Roxb.

561.11 Relations between height and volume of *Dipterocarpus alatus* Roxb.

561.12 Study in the growth of teak during the seasons of 1949–1958.

561.13 Relations between diameter increment of teak and the thickness of soil in the A–horizon in the teak plantation of 1942, Me Thark forest, Lampang.

561.14–20 Relations between the growth of teak and thickness of soil in the A. horizon in the taak plantations of 1943–1949, Me Thark forest, Lampang.

561.21 Relations between the height of teak and the thickness of soil in the A–horizon in the teak plantation of 1942, Me Thark forest, Lampang.

561.22–24 Relations between the height of teak and the thickness of surface soil in the teak plantation of 1943–45.

561.25 Relations between the growth of teak and the amount of precipitation in September and October during the year 1950–1959, Me Thark teak plantation, Lampang.

561.26 Relations between the growth of teak and the thickness of soil of the B–Horizon, Me Thark teak plantation, Lampang.

567.0 Commercial volume table of *Pentacme siamensis* Kurz.

568.0 Classification of teak through the Keen method.

569.0 Stem analysis of *Shorea obtusa* Wall.

569.1 Stem analysis of *Dipterocarpus tuberculatus* Roxb.

569.2 Stem analysis of *Pentacme siamensis* Kurz.

569.3 Chemical analysis of the bark, sapwood and heartwood of *Terminalia mucronata* Craib & Hutch.

569.4 Chemical analysis of the bark, sapwood and heartwood of *Terminalia alata* Heyne

58. Forest Inventory, Stratification system.

Forest Management

684.0 Survey of the livelihood of the peasants living in Me Huat forest, Lampang.

Marketing

71.0 Devaluation of the commercial value of *Shorea obtusa* Wall. and *Pentacme siamensis* Kurz. logs through defects.

Social Economics of Forestry

906.0 Economic justification in establishing *Casuarina junghuniana* Miq. var. plantations.

906.1 Economic justification in establishing teak plantations.

902.0 History of the establishment of *Dalbergia cochinchinensis* Pierre. plantations in Thailand.

902.1 Compilation of informations on *Casuarina equisetifolia* Linn. and *Casuarina junghuniana* Miq. var.

Besides the above, the Faculty of Forestry, Kasetsart University also uudertakes research on 3 projects jointly with the Royal Forest Department viz.

1) Erosion and run–off from burnt and unburnt plots in the natural forests and teak plantations.

2) The identification of soil properties which may be significantly correlated with the growth of teak forests.

3) The identification of native timbers by macroscopic and microscopic characters and the building up of an identification and a card-sorting key through the above characters.

Research is also being carried out by members of tbe Forestry Faculty, in the following subjects:

Factors of the Environment, Biology

1. Plant succession in burnt and unburnt teak forests ann plantations, Me Huad – Me Thark forests, Lampang.

Silviculture

2. Study of the regeneration and establishment of *Hopea ferrea* Pierre. in Phu Lhaung—Wang Nam Kheo forest, Nakorn Rajasima.

3. Budding of teak.

4. The effect of various thinnig intensities on the increment of teak plantations, Me Huad–Me Thark forest, Lampang.

5. The effect of pruning on the growth of *Casuarina equisetifolia* Linn. in plantations at Huey Yang forest, Prachuab Kirikhan.

Forest Injuries and Protection

6. Effect of fire – protection on the growth of *Shorea obtusa* Wall. and *Pentacme siamensis Kurz.* in Phu–Lhaung Wang Nam Kheo forest, Nakorn Rajasima.

7. Effect of fire protection on the regenaration and establishment of *Shorea obtusa* Wall. and *Pentacme siamensis* Kurz. in Phu Lhaung – Wang Nam Kheo forest, Nakorn Rajasima.

8. Poisioning of weed trees by the use of 2,4–D, 2,4,5–T and sodium arsenite of different intensities in Phu Lhaung–Wang Nam Kheo forest, Nakorn Rajasima.

9. The incidence of teak bee–hole borers in teak plantations of various ages, Me Huad–Me Thark forest, Lampang.

Forest Mensuration

10. Compilation of commercial volume table for *Dipterocarpus tuberculatus* Roxb. in Phu Lhaung–Wang Nam Kheo forest, Nakorn Rajasima.

11. Seasonal increment in girth of *Dipterocarpus alatus* Roxb. in Phu Lhaung–Wang Nam Kheo forest, Nakorn Rajasima.

12. Comparison of per cent and method of cruising in Dry Deciduous Dipterocarps forest, between the Swedish tract unit system, strip system and and line plot system in different degrees of cruising (0.5,1.0 and 5.0%).

Forest Products

13. Use of hydrochloric acid in spraying tapping wounds of Dipterocarpus spp. for the yield of oleo-resin.

On the forest products side, research as carried out by the Forest Products Research Division of the Royal Forest Department, has been progressing steadily, though also hampered by inadequacy of fund and personnel. The results achieved up to the present may be briefly summarised as follows:

About 60 per cent of the timber tree species of the country has been botanically studied and 90 per cent of the reserved tree species has been identified scientifically.

Zoological survey is at the beginning, and only a few problems on insect pests are under critical studies at present.

Lacquer tapping form *Melanorrhoea usitata* Wall. has been carried out to improve the conventional method of tapping for the purpose of increasing yield and to find the most appropriate method for exploiting and conserving lacquer trees.

Nothing of particular interest, however, has been achieved in the projects on wood working, owing to lack of competent authority.

Mechanical testing of timber is being carried out to revise the former data of previous testing. The card key system is being applied in the study of wood structure and keys for 100 species are in the course of preparation.

Destructive extraction of timber has been under the study program for a number of years with the co-operation of the government saw-mills.

Fibre length studies of some Thai woody species and bamboos, have been taken up but the studies are not yet concluded.

Comparative study of the preservation of inferior timber species, between the pressurized and open-tank methods, has been undertaken and comparative study of timber seasoning by dry-kiln and open-air methods is being carried out with special reference to teak and Dipterocarpus timbers.

Lac development has been promoted through the extension service, but the selection of the best host trees for higher yield and better quality of lac and the development of better strains of the lac insects are also under study.

A progress report on weathering test of plywood was published at the end of 1960, showing the gluing property of plywood, using teak, *Dipterocarpus* spp. and *Tetrameles nudiflora* R.Br. as face, back and core after exposure to the weather for a period of not less than 2 years.

Problems in forest products that are being investigated by the Forestry Faculty, Kasetsart University, during 1957-1960. were:-

Factors of the Environment, Biology

1. Assaying soils for numbers of actinomycetes antagonistic to microbial pathogens.

Marketing

2. Study on the relationship between size and price of teak logs.

Forest Products and Their Utilization

3. The identification of the genus *Dipterocarpus* Gaertn. F.

4. The identification of the timbers of the family Leguminosae.

5. Microscopic studies of comercial Thai woods.

6. Microscopic studies of treated Thai woods.

7. Study on the mechanical properties of *Bambusa blumeana* Schult.

8. Study on the mechanical properties of *Thysostachys siamensis* Gamble.

9. Preparation of material for microscopic studies.

10. Physical and mechanical properties of the wood of *Casuarina junghuniana*. Miq. var.

11. Study on the working time of band saw.

12. Study on the out-turn percentage in the conversion of teak logs.

13. Modernization of the Thai saw-mill.

14. Study on oil-borne wood preservatives in the treatment of Thai woods.

15. Study on water-borne wood preservatives in the treatment of Thai wood.

16. Study on fiber saturation point of Thai woods.

17. Study on the effect or seasoning veneer for making plywood.

18. Moisture distribution of wood during drying process.

19. Study on weight of standard size of teak conversions at air-dry condition.

20. Study of the correction factors used with capacity type electrical moisture meter for teak.

21. Study of the technique of flush-door production.

22. Study of the quality of sliced-cut teak wood veneer.

23. Study of the technique in plywood production.

24. Study of the cost of plywood production.

25. Study of veneer grading.

V. RESEARCH PROJECTS OF HIGH URGENCY

According to the 6 years economic development program of Thailand, starting from 1961, the Government aims to keep about 40 per cent of the area of the country i.e. 200,000 square kilometres or 20,000,000 hectares permanently under forests. About half of these 20,000,000 hectares of forest will probably be managed mainly for their protective value and the remainder for the production of timber, fuelwood, poles, industrial woods and bamboos on a sustained yield basis. As the population of Thailand (25.5 millions in 1960) is increasing rapidly at the rate of 2.8 per cent per year, the requirement of the population for forest produces and other amenities from the forests will put quite a great strain on the forest resources of the country in the very near future.

Problems in forestry needing urgent solutions, are how to manage the forests to give permanent and better yield of water for irrigation and hydro-electric projects and to increase the yield of timber, fuelwood and indutrial woods per unit of area in order to meet the requirement of the country.

Of these 2 vast problems, very little research has been done, especially on the problem of water yield.

As about 60 per cent of the forests in the principal catchment areas of the country had been destroyed by shifting cultivations, and the destruction is still going on at a rapid rate by about 200,000 members of various hill-tribes, the urgency of initiating protective measures for these catchment areas is imperative. The correct management of these catchment areas or wartersheds can be

carried out only through comprehensive research of the various factors effecting water yield. Watershed management research in all phases, should therefore, be given top priority in the drawing up the research program of the country and should be implemented in the 6 years economic development program as mentioned above.

On the problem of increasing yield of forests products per unit of area, this should be solved by:

1) Better and more correct methods of management of the natural forests, especially in the fixation of rotation and yield in harvest cutting.

2) Establishment of plantations on suitable sites, especially of teak and other fast growing species.

3) Securing of adequate natural regeneration, especially of the evergreen dipterocarp species, the dipterocarps of the Dry Deciduous dipterocarps forests and the principal species of the mangrove forests.

4) Protection of plantations and naturally regenerated areas from fire and insect pests.

5) Increasing the growth and yield from plantations and the natural forests through proper cultural operations and the selection and breeding of high yielding strains,

6) Conservation of the fertility of forest soils and soils in plantations, through proper soil conservation and fire-protection measures.

Realization of the above objectives can be obtained only through research properly carried out and vigorously pursued; and it is hoped that the authorities entrusted with forest research in Thailand should co-operate in finding ways and means to draw up a workable forest research program and spare no effort to have the program implemented and financially supported by the government.

It is however most gratifying to remark in conclusion that H.M. King Phumiphol is highly interested in forest research and has initiated research on the raising and planting of *Dipterocarpus alatus* Roxb. recently in the ground of Chitlada Palace in Bangkok. He has also graciously allowed students of the Forestry College, Kasetsart University, to conduct experiments in the shading of seedlings and in the application of fertilizer, so the knowledge gained may be widely disseminated to those interested in the planting of this species.

It is hoped that his gracious 'example' may well herald a new era in forest research in Thailand and places forest research in its proper niche in the economic development program of the country.

VI. ABSTRACT

With the advent of forestry to Thailand in 1896, forest research has progressed rather slowly owing to inudequate support and lack of competent personnel. Much had been accomplished, however, in the field of botanical research, especially in the identification of the more important indigeneous timber trees and economic plants of the country.

At present, forest research is being conducted mainly by the Royal Forest Department and the College of Forestry, Kasetsart University, both of them, being governmental institutions. Research by private institution and industry is negligible.

The Royal Forest Department has a well-equiped forest products research laboratory in Bangkok and 6 regional forest experimental stations in different parts of the country.

Current problems of research are the studies of the silvical characteristics of teak and other important timber trees of the country, their propagation and tending; forest soil sites as affecting the growth of teak; preliminary studies on run-off and erosion from denuded land and burnt and unburnt forests, reforestation of cut-over lands and research in the cultivation and propagation of the lac insects.

Research in forest products is mostly concerned with the studies of the physical and mechanical properties of native woods, their response to seasoning and preservative treatment as well as their suitability for use in various industries.

A most urgent problem of research which should have high priority in the program planning of research in Thailand, is watershed management research, considering the rapid rate of forest destruction by hill-tribes at the head-waters of the principal rivers of the country and the extensive plan now being developed for the harnessing and utilization of water resources for power and irrigation purposes.

เรื่องย่อ

ตั้งแต่รัฐบาลได้เข้าเริ่มดำเนินกิจการป่าไม้ในประเทศไทย ใน พ.ศ. 2439 เป็นต้นมานั้น การวิจัยทางวนศาสตร์ได้ก้าวหน้าไปอย่างค่อนข้างเชื่องช้า เนื่องจากขาดการส่งเสริมสนับสนุนและเจ้าหน้าที่ที่มีคุณวุฒิเพียงพอ แต่ในด้านการค้นคว้าทางพฤกษศาสตร์ นับว่าได้จัดทำไปได้ผลดีพอสมควร โดยเฉพาะในเรื่องพิสูจน์ชื่อของไม้ที่สำคัญ ๆ ที่นิยมใช้สอยเนื้อไม้กันมาก และในการพิสูจน์ชื่อพรรณไม้ต่าง ๆ ที่มีความสำคัญในทางเศรษฐกิจของประเทศ

ในปัจจุบันกรมป่าไม้ และคณะวนศาสตร์ มหาวิทยาลัยเกษตรศาสตร์ ซึ่งทั้ง 2 แห่งเป็นสถาบันของทางราชการ ได้เป็นผู้ดำเนินการวิจัยทางวนศาสตร์เป็นส่วนใหญ่ ส่วนการวิจัยที่จัดดำเนินการโดยสถาบันหรืออุตสาหกรรมส่วนบุคคลนั้น นับว่ามีน้อยมาก

สำหรับกรมป่าไม้ในขณะนี้มีห้องทดลองเกี่ยวกับผลิตผลป่าไม้ ซึ่งมีเครื่องอุปกรณ์ในการวิจัยดีพอสมควร อยู่ในพระนคร ฯ หนึ่งแห่ง และมีสถานีวนกรรมตามภูมิภาคต่าง ๆ ของประเทศอยู่รวม 6 สถานีด้วยกัน

ปัญหาการวิจัยทางวนศาสตร์ที่สำคัญ ๆ ซึ่งกำลังจัดทำอยู่ในปัจจุบันมีการศึกษาเกี่ยวกับลักษณะทางวนวัฒน์ของไม้สัก และไม้ชนิดที่สำคัญอื่น ๆ การขยายพันธุ์และการบำรุงพรรณไม้ต่าง ๆ ดังกล่าว การศึกษาเกี่ยวกับดินในถิ่นต่าง ๆ ที่มีผลต่อการเติบโตของไม้สัก การศึกษาเบื้องต้นเกี่ยวกับสูญเสียน้ำและดินจากพื้นที่ที่ป่า

ถูกแผ้วถางและป่าที่ถูกไฟไหม้ และได้รับการป้องกันไฟ การปลูกสร้างป่าใหม่ในที่ที่ถูกแผ้วถางไปแล้ว และการวิจัยเกี่ยวกับการเพาะเลี้ยงและขยายพันธุ์ครั่ง เป็นต้น

ส่วนในด้านผลิตผลป่าไม้ ได้ดำเนินวิจัยส่วนใหญ่ไปในการศึกษาถึงเรื่องสกายะสมบัติและกลสมบัติของไม้ที่มีอยู่ในประเทศ การอบและอาบน้ำยาไม้เหล่านั้น ตลอดจนถึงการนำไม้ดังกล่าวไปใช้ในกิจการอุตสาหกรรมต่าง ๆ เพื่อดูว่าจะมีความเหมาะสมเพียงใด

ปัญหาการวิจัยที่มีความจำเป็นเร่งด่วน ที่ควรจะได้รับการพิจารณาเป็นอันดับแรก ในการวางแผนงานวิจัยทางวนศาสตร์ในประเทศไทย คือ การวิจัยเกี่ยวกับการจัดการลุ่มน้ำ เนื่องจากได้มีการแผ้วถางทำลายป่า ที่เป็นต้นน้ำลำธารของแม่น้ำที่สำคัญๆ ของประเทศโดยชาวเขาเผ่าต่างๆ อยู่อย่างแพร่หลายและรวดเร็วในปัจจุบัน และเนื่องจากได้มีการวางโครงการอย่างกว้างขวางที่จะพัฒนาและใช้ประโยชน์น้ำเพื่อการพลังงานและการชลประทานอยู่ในขณะนี้