2016

Annual Report

Taiwan Forestry Research Institute

行政院農業委員會林業試驗所

一〇五年度年報

序

2016 年 4 月 22 日適逢「世界地球日」，全球 175 個國家代表群聚在美國紐約市聯合國總部，簽署前於 2015 年 12 月 12 日在法國巴黎通過的「全球氣候協議」，簡稱「巴黎協議 (Paris Agreement)」。聯合國秘書長潘基文難掩興奮地表示，「這是歷史性的時刻」，因為它不但締造單日最多國家簽署國際協議的新紀錄，也是拯救地球最佳時機的重要里程碑。根據該協議，各國必須以工業革命前 (1750 年) 的全球均溫為基準，追求在本世紀結束前，全球均溫上升不超過攝氏 2 度，並以不超過攝氏 1.5 度為目標。換言之，全球應儘快實現讓溫室氣體的排放達到峰值，並在本世紀下半葉實現溫室氣體的淨零排放，以便將人類活動所排放的溫室氣體總量，降低到讓樹木、土地、海洋自然吸收的水準。這確實是一個高難度的挑戰！

值得注意的是，全球森林議題在巴黎協議中所受到的重視與共識，被認為具有重大突破；甚至有外國媒體報導，森林才是巴黎協議的大贏家。其原因在於巴黎協議簽署之際，國際社會已從 1997 年「京都議定書」的思維 (將森林因應氣候變遷的功能，僅定位在單純減緩的角色)，轉換為如何提高森林調適的能力。主要進展包括：從原本對於人工林碳匯量的關注，轉變到人工林與天然林兼顧；從增加碳匯以減緩氣候變遷的思維，進化到納入加強既有碳庫的森林保育調適；從看待森林碳效益的單一角度，擴及至森林生態系多元服務的廣度；從單純考量森林本身的存續問題，轉為整體考量森林與賴其維生之社區群間的共生課題。這些觀念的轉變，勢必影響到未來各國在因應氣候變遷時，森林經營者的態度與策略。

作為參與林業行政與研究工作近 40 年的老兵，我經常以「全球思維、在地作為 (global thinking, local action)」與同仁共勉。面對 2016 年世界氣象組織 (WMO) 所提出的警訊，2011-2015 年是人類有氣象紀錄以來最燠熱的五年，氣候變遷已使得極端氣候的風險倍增且未見稍歇。這意味著吾人今後在保護森林生態系統時，勢必變得更加困難卻也更顯重要。有鑑於此，本所未來在研提各項計畫時，必需從多元面向加以思考，包括：生物多樣性 (棲地保護、物種保育、基因保存、樹木保健)、氣候 (減緩變遷、調適變遷、災害應變)、森林價值 (永續經營、林產品及貿易、林下經濟、循環經濟)、民眾福祉 (在地與非在地居民權益、林園療癒、共享經濟) 等，以期使本所之研究品質能與時俱進。

物理學大師阿爾伯特 • 愛因斯坦 (Albert Einstein) 曾說「當我們的知識之圓擴大時，我們所面臨的未知圓周也一樣。」誠哉斯言，人類如今所擁有的知識與遭逢的環境危機也正是如此。雖然森林不是萬能，但人類沒有健康的森林而想苟活，則是萬萬不能。其實愛因斯坦還說了另外一句話「並不是我聰明，只是我和問題相處的時間較久。」值此年報出版，謹借花獻佛改為「並不是森林有多重要，只要你和森林相處的時間夠久就會知道。」

行政院農業委員會林業試驗所

所長 黃裕星 謹誌

2017年10月

Preface

On "World earth day" April 22nd, 2016, representatives of 175 countries in the world gathered at the Headquarters of United Nations, New York City to sign the "Global Climate Agreement" or "Paris Agreement" which has been passed on 12th, December, 2015. The UN Secretariat General Dr. Ban Ki-moon excitedly proclaimed "This is a historical moment," because it not only held the new record of the most countries signing an international agreement in one day, but also an important milestone in the endeavor of human to save the earth at an opportune moment. According to the agreement, countries of the world must use the pre-industrial revolution global temperature as the basis and pursue the goal that at the end of this century, the global average temperature shall not rise by 2 degree Celsius, and to hold an upper threshold of 1.5 degree. In other words, worldwide, we should realize greenhouse gases emission reaching peak as soon as possible, and to reach net zero emission of greenhouse gases in the second half of the century, so that the total greenhouse gases emitted by anthropogenic activities shall reduce to a level capable of being naturally absorbed by trees, earth, and ocean. This is indeed a very difficult challenge!

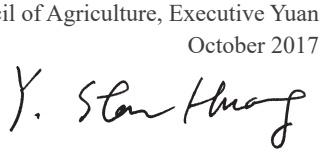
It is noteworthy that the global forestry issues received emphasis and consensus, and being regarded to have breakthrough significance; there was a foreign medium report saying that forests were the biggest winners of the Paris Agreement. The reasons being that at the time of the signing of Paris Agreement, the global society has transformed from the 1997 Kyoto Protocol thinking (regarding forests in coping with climate change as being simply an abatement role), to how to enhance the capability of forests to adapt. The main advances included: from the original concerns of plantations as carbon sink to encompass both plantations and natural forests; from the thinking of increasing carbon sink so as to mitigate climate change to advance to an adaptation of forest conservation including the existing carbon sink; from a singular angle of regarding forests having carbon efficiency to expand to great width of forest ecosystems as having multiple services; and from simply consider the presence and continuity of forest itself to a consideration of forest and communities of lifeforms depending on it as symbionts. These transformations of ideology will certainly influence countries of the world on the attitudes and policies of their forest managers in coping with climate change.

As a forty-year veteran of forestry administration and research work, I've always used "global thinking, local action," to encourage my colleagues. Facing with the stern warning proffered by the World Meteorological Organization (WMO) in 2016, the years 2011 to 2015 were the hottest 5 years in climate records. Climate change has caused risks of extreme weather to multiply and is showing no sign of abatement. These mean that henceforth in our effort to protect the forest ecosystem, we shall encounter greater difficulties and our work shall appear more important. In view of these, in the future, when TFRI is screening for research projects, multifaceted thinking must be deployed, these include: biodiversity (habitat protection, species conservation, gene preservation, and tree health); climate (abate change, adapt to change, and disaster restoration); forest valuation (sustainable management, forest products and trade, understory economy, circular economy); people's welfare (local and nonlocal residents benefits, forest therapy, sharing economy) etc. so that the research quality of TFRI shall advance with time.

The great physicist Albert Einstein once said "As our circle of knowledge expands, so does the circumference of darkness surrounding it." This is so true. The knowledge possesses by mankind today and the environmental risks we face are exactly like this. Although forest is not omnipotent, mankind certainly can't survive without healthy forests. As a matter of fact, Einstein also said "It is not that I'm smart, it's just that I stay with problems longer." At the time of publication of this yearbook, I would paraphrase the sentence as "It's not that how important forest is, only when you stay with forest long enough and you'll know."

Director General, Taiwan Forestry Research Institute, Council of Agriculture, Executive Yuan

October 2017



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前言

Introduction

前言

林業試驗所105年度編制員額為147人，歲入預算數8,755千元，較上年度減列2,418千元，歲出預算數637,068千元，較上年度增列45,777千元。為利各界瞭解本所105年度施政概況，本年報依例以計畫領域為編輯軸心，收錄已結案之計畫成果60項，分為三類呈現：一、林業科技試驗研究計畫41項(佔68.3%)。二、林業發展計畫暨所外委辦計畫12項(佔20.0%)。三、科技部補助專題研究計畫7項(佔11.7%)。除完成各類計畫外，105年度亦落實多項施政簡述如次：

一、在林業資源生產技術研究方面：完成紅豆杉、土肉桂等共10個具有潛力的品種/系；選育與繁殖休耕地短伐期樹種如相思樹、桉樹等，建立三處造林示範區10公頃；繁殖苗木紅豆杉1萬株、桉樹2萬株；推廣桉樹造林20公頃；發展混農林業與林下經濟的作物包括山葵、松露等，開發栽培繁殖體系；完成5種短期樹種育苗造林生長調查與伐採利用，證實可以作為菇木原料；利用轉殖野生型農桿菌基因，成功建立青脆枝與粗樞毛狀根系，並於生物反應器大量培養。

二、在樹木健康管理及樹木保護研究方面：建立樹木根基部腐朽病害南方靈芝及熱帶靈芝之PCR套組檢測技術；完成30種鱗翅目及鞘翅目蛀食性昆蟲COI基因的序列資料庫建立；完成108種國內林木蛀食性害蟲的資訊及名錄；完成長喙殼菌屬之形態鑑定及分子序列分析；完成六龜及信賢苗圃誘引器的設置，以定期監測森林中小蠹蟲的種類及族群數量；由樹木醫學中心提供樹木病蟲害診斷及防治諮詢服務1,646件；辦理樹醫相關講習班18場超過1,000人次參加。

三、在試驗林生態系示範經營方面：完成造林間植撫育作業7.5公頃；執行林地巡護823次及林地巡視抽查作業4次；完成六龜、太麻里研究中心林道災害緊急搶修；完成恆春研究中心龜仔腳氣象站儀器更新與港口氣象站維修與校正；完成太麻里研究中心麥里蘆氣象站之遷移；完成福山一號、二號及蓮華池二、三、四、五號試驗集水區量水堰之清淤及聯絡道路維護並恢復觀測。

四、在國家植物園建設方面：辦理臺北植物園120週年紀念研討會活動及11場次特展；於臺北植物園蒐集原生植物1,175種共1,319株；於林木種子庫新增106個種子保存組；於福山植物園蒐集臺灣原生蘭科植物83種共260株，並於園區進行1千7百餘株植物每月2次的物候調查；完成坪林臺灣油杉區外保育區108株扦插苗之維護及撫育；於恆春熱帶植物園辦理莫蘭蒂颱風之災後復舊工作，另架設自動相機10台監測梅花鹿活動，以研擬植栽保護措施；於植物標本館完成20,106份植物標本製作及資料建置工作，並完成植物標本數位影像16,053份；辦理標本資料庫網站查詢服務9,348人次。

此外，本刊亦收錄105年度之重要記事、專題演講、出版品、技術移轉案件、發表報告、預決算、人力資源等訊息，提供各界檢視本所當年度之整體施政成果。

Introduction

In 2016, the Taiwan Forestry Research Institute had an official staff of 147 persons, with annual budget income of 8,755 million NT dollars, which was a reduction of 2,418 million dollars from a year ago; an annual budget of 637,068 million dollars, which was a gain of 45,77 million dollars from a year ago. In order for readers to understand the administrative status of TFRI in 2016, this yearbook follows previous examples and edited according to project domains and complied 60 items of completed project results, which were grouped into three categories: 1) forty-one items of forestry science and technology experimental research projects (accounted for 68.3% of the total); 2) twelve items of forestry developmental projects and external entrusted projects (accounted for 20.0% of the total); and 3) seven items of Ministry of Science of Technology supported research projects (accounted for 11.7% of the total). In addition to the completed projects, in 2016 various motley items of administrative achievements are briefly described as follows:

Ⅰ. On forestry resources production technological research aspect: We've completed 10 strains of potential provenances of Taiwan yew (*Taxus mairei*) and indigenous cinnamon tree (*Cinnamomum osmophloeum*); selective bred and propagated short-rotation tree species such as Taiwan acacia (*Acacia confusa*), and eucalyptus spp. etc. for fallow land and we've setup three afforestation demonstration plots totaling 10 hectares; we've propagated 10,000 Taiwan yew seedlings, and 20,000 eucalyptus seedlings; promoted eucalyptus afforestation of 20 ha.; developed agroforestry and understory crops such as wasabi and truffles, and established their cultivation and breeding system; completed 5 short-rotation tree species afforestation growth survey, harvesting and utilization, which were proven to be suitable for growing shiitake mushrooms; utilized transgenic wild-type Agrobacteria genes to successfully established hair-like root systems of foetid nothapodytes (*Nothapodytes foetida*) and Taiwan plumyew (*Cephalotaxus wilsoniana*), and mass cultured them in a bioreactor.

Ⅱ. On tree health management and tree protection research aspect: We've established a PCR diagnostic kit technology for Ganoderma austral and G. tropicum, both tree root decaying fungi; completed 30 species of lepidopteran and coleopteran boring insects cytochrome c oxidase I (COI) gene sequencing database; completed 108 species of domestic forest tree boring insect pests information and name list; completed morphology-based identification and molecular sequencing analysis of Ophiostomataceae fungi; completed installation of insect lures at Liukuei and Hsinshien nurseries, so as to periodically monitor the kinds and population of bark beetles in the forests; provided 1646 cases of tree diseases and insect pests diagnostics and prevention services; held 18 sessions of tree medical-related courses with participants exceeding 1,000 persons.

Ⅲ. On demonstrative management of experimental forest ecosystem aspect: We've completed inter-planting and tending operations of 7.5 ha forestland; executed forestland cruise 823 times and spot check of forestland operations 4 times; completed emergency repairs of forest road in Liukuei and Tamalee Research Centers; completed instrumental renewal of Gueitzejiao meteorological station and maintenance and calibration of Gangkou meteorological station in Hengchun Research Center; completed relocation of Maililu meteorological station in Tamalee Research Center; completed debris removal and connecting roads maintenance and resumed observations of water measuring weirs at Fushan no.1, no.2, Lienhuachih no.2, no.3, no.4, and no.5 watersheds.

Ⅳ. On the construction of national botanical garden aspect: We've held a memorial symposium in honor of 120th anniversary of Taipei Botanical Garden and 11 sessions of special exhibition; collected and maintained 1,175 species of 1,319 endemic plants at Taipei Botanical Garden; newly added 106 seed preservation lots at the tree seed bank; collected indigenous Taiwan Orchidaceae plants 83 species and 260 plants at Fushan Botanical Garden, and conducted twice monthly phenological surveys of more than 1,700 plants in the garden; completed maintenance and tending of 108 cutting seedlings of Taiwan keteleeria (*Keteleeria davidiana*) in an exo-situ conservation plot at Pingling; conducted post-typhoon restoration at Hengchun Tropical Botanical Garden after Typhoon Meranti struck, in addition, 10 automatic cameras were setup to monitor activities of Formosan sika deer, so as to plan protective measures for the plants; completed 20,106 pieces of plant specimens preparation and database setup, also completed 16,053 digital imageries of the plant specimens; transacted 9,348 person-time of specimen information network inquire services

In addition, in this yearbook we've recorded the chronicles of important events, special lectures, publications, technical transfer cases, papers published, budget and financial accounts, and human resources etc. transpired in 2016, so that the administrative achievements of TFRI in the year can be presented in total for the readers to peruse.

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研究計畫推動及成果

Development and Results of Research Projects

山葵健康種苗之育成與栽培技術之研發

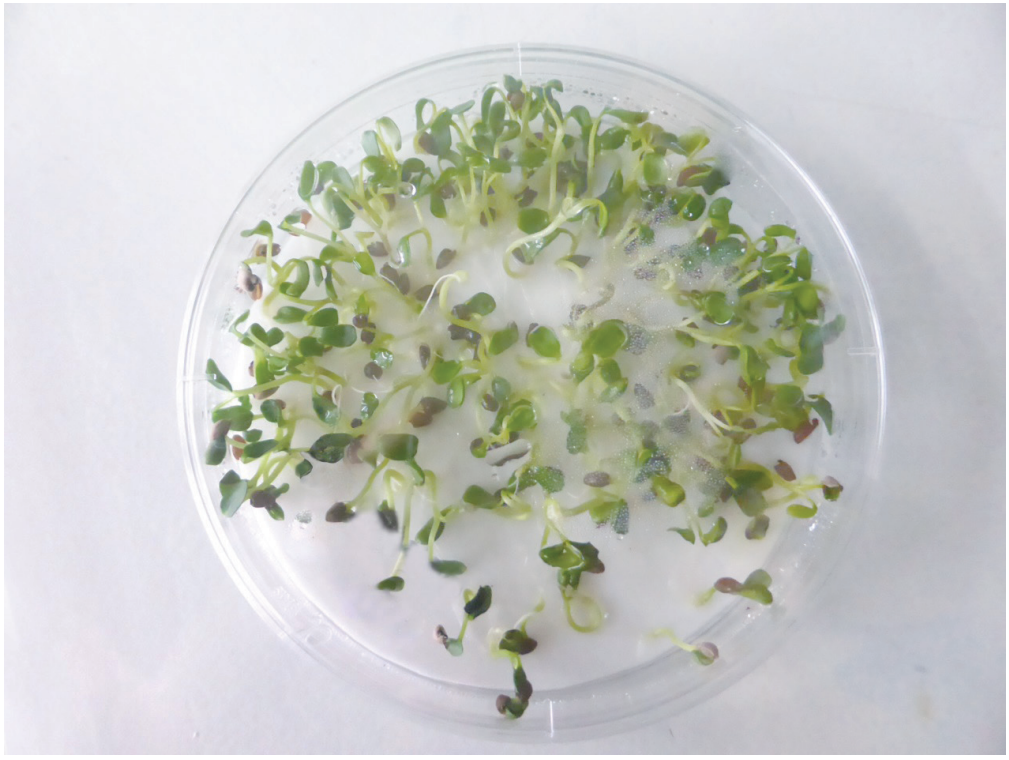
The R&D on the Nurturing and Culture Technology of Healthy Seedlings of *Wasabia japonica* Matsum

黃怡菁、傅春旭

I-Ching Huang, Chuen-Hsu Fu

本計畫為開闢山葵成為在臺灣永續栽培的新興產業，所以進行山葵健康種苗之育成與栽培技術，並健康種苗於定植後之標準生產及病蟲害的管理程序的研訂。而目前我們也已完成預定的進度。我們已建立「山葵種子貯藏及整齊實生苗之促成栽培技術」，這個技術內容含有1.山葵新鮮種子於採收後的貯藏方法，包括種子在貯藏前的消毒方法、分裝方式，貯藏介質、貯藏條件及貯藏期限。2.新鮮種子及經過各個不同貯藏期之種子的整齊發芽技術。3.經整齊發芽後之實生苗的促成育成技術，即使實生苗快速整齊長成具有3片以上本葉之定植苗的技術。我們正進行這個技術的非專屬授權技轉鑑價及後續可以技轉給業者使用的相關程序，相信很快就可以技轉給業者使用，而帶給山葵產業正面的影響。

To promote the culture industry of *Wasabia japonica* Matsum to be a new sustainable industry in Taiwan, in this program we research and establish the SOP on the nurturing, culture technology and pest control of healthy seedlings of *Wasabia japonica*. And we are on schedule. We have set up "The seeds storage technology and neatly seedling forcing technology of *W. japonica*." This technology includes the following issues: 1. the storage technology for the fresh seeds of *W. japonica*, including sterilization procedure before storage, packing method and storage medium, and the condition and deadline of storage; 2. The neat germination technology for the stored seeds of *W. japonica* with different stored period; 3. The forcing technology for the seedlings of *W. japonica* after germination, to let the seedlings grow fast and neatly to a stage having more than 3 true leaves. Now, the transfer price of this technology is being evaluated and the following procedure for the authorization is being determined. We believe this technology will soon be able to transfer to the industry, and bring positive influence on the culture industry of *W. japonica*.



山葵種子整齊發芽。

Neat germination of the seeds of *Wasabia japonica* Matsum.

創構產業優化多元服務發展平台計畫

Plan for Optimization of Constructing Industrial Development Platform Providing Multiple Services

陳燕章、胡元瑋

Yen-Chang Chen, Yuan-Wei Hu

本計畫透過農業委員會所屬創新育成中心及農科院育成中心朝向聯盟形式發展，共同推動創業育成。今年每季定期召開工作小組會議，促進各項工作的進行，並於林業試驗所、農業試驗所設立廠商服務定點諮詢中心，內容包含專利智財、財務、技術移轉、市場行銷、經營管理及人才媒介等服務，規劃明年於畜產試驗所增設定點諮詢中心，建立完整的北中南區諮詢服務網絡，讓業者能即時獲得育成整合性資源，達成前育成至後育成一條龍式之完整育成服務。本(105)年度透過北中南三場聯合招商說明會，以及北中南東四場農企業輔導資源聯合說明會，進行聯合招商、宣傳及推廣活動，藉此說明研發成果加值、產學合作、農業科技專案計畫、育成中心及農企業輔導等方案。

本所本年度新進駐家數2家(永在林業生產合作社及臺灣利得生物科技股份有限公司)，累積輔導5家進駐業者，促進投資6,864千元，促進就業人數11人，進駐廠商承接技術授權案計1件(樹木注射技術)，授權金額為50千元。

The purpose of this project is to promote the innovation incubation of agricultural industry, through the united cooperation of the Innovation Incubation Centers (IICs) of the Council of Agriculture and the Agricultural Technology Research Institute. Working group meetings were held quarterly this year to guarantee the smooth operation of these Centers. Consulting stations were set up at the Taiwan Forestry Research Institute and Taiwan Agriculture Research Institute this year to offer consulting services on patent and intellectual properties, finance, technology transfer, marketing, management and control, manpower mediation, etc. Another station will be established at the Taiwan Livestock Research Institute next year to accomplish the Northern, Central, and Southern Consulting Network. Thus, the company can access to the real time integrated incubation resources and the complete pre-incubation and post-incubation services. This year, through the joint investment seminars held in Northern, Central and Southern Taiwan, as well as the joint explanation meeting on agribusiness consulting resources held in Northern, Central, Southern, and Eastern Taiwan, value-added research findings, academy and industry cooperation, agricultural technology development program, innovation incubation centers and agribusiness consulting programs were explained and discussed.

There were 2 more companies (Yong-Zai Forestry and Taiwan Leader Biotech Corp.) entered IIC this year and 5 in total so far. A total of 6,864,000 NT dollars were invested and 11 persons were employed. One technology (The trunk injection technology) was transferred to a stationed company and the license fee was 50,000 NT dollars.

智慧生態計畫－生態及生物多樣性資訊基礎建設與應用計畫

陳燕章、鄭美如

本計畫為透過目前已發展成熟的生態資訊學技術，用感測網的部署以收集長期生態觀測資料，建構我國生態與生物多樣性整合資訊管理系統，並依循全球生態資料交換標準與網路運算技術建置資料倉儲、展示與資料公開之共享平台，與國際接軌。透過資料倉儲與網路應用系統的開發，提供分眾、主動、全程之生態知識服務，以為國內學術研究、大眾環境教育及政府決策機關運用，做為全球氣候變遷與生物多樣性保育的基礎資料來源之一。

本計畫所建置的生態感測網絡平台，串接了臺北植物園、蓮華池試驗林及六龜扇平生態科學園區的網路基礎設施與生態監測硬體設備，包含了11個聲景監測點、3個影像監測點及6個氣象監測點，所收集的資料包含蛙類聲景、菱形奴草影像、荷花池影像及各種基礎氣象資料。在人工資料收集方面，每周進行臺北植物園花曆植物物候調查與開花照片拍攝，另外也定期赴試驗林地收錄自動相機所紀錄到的野生動物活動影像。所收集的各項資料已累計超過40萬筆，均以開放格式於生態感測展示平台對外提供。此外，完成了蓮華池3個氣象塔的避雷設施改善與動態樣區光纖網路節點增設，及蛙類聲音標音及自動辨識軟體的初步開發，以降低人工辨識蛙類鳴叫的時間與人力。

在教育推廣方面，出版了《誰得到好處？一森林大宅院的秘密》生態感測繪本、《繽紛花現一臺北植物園開花紀實》推廣摺頁及《大自然的神奇寶貝》學習卡，並辦理了6場次的生態感測自然探索活動或教師研習營。

生態感測展示平台網站 http://iesn.tfri.gov.tw。
The Ecological Sensor Network Website http://iesn.tfri.gov.tw

Intelligent Ecology Program - the Information Infrastructure Establishment and Application for Ecology and Biodiversity Researches

Yen-Chang Chen, Meei-Ru Jeng

This program used the well-developed intelligent ecology techniques and allocation of sensor network to collect long term ecological observation data and to establish the integrated information management system for ecology and biodiversity researches. We followed the global ecological data exchange standards and the internet calculation techniques to construct an internationalized sharing platform for data storage, display, and openness. Through the development of data storage and internet application system, we differentially, actively, and fully supplied ecological knowledge service, as a basic source of global climate change and biodiversity conservation information, for domestic academic research, public environmental education and governmental institutes to apply.

The basic internet apparatus and ecological sensing hardware were connected by the Ecological Sensor Network established in this project. There were 11 audio-scape monitoring points, 3 images monitoring points and 6 meteorological monitoring points. Data of frog audio-scape, *Mitrastemon kanehirai* photos, lotus pond photos, and basic meteorological information were collected. The phonological status and blooming pictures of the Floral Calendar Plants in Taipei Botanical Garden were surveyed and photographed every week. The video of wildlife activities recorded by automatic cameras were periodically collected from the experimental forests. More than 400,000 data were accessible to the public on the Ecological Sensor Network Website. The lightning conductor of 3 meteorological towers in Lien-Hwa-Chih, more nodes of light-fiber networks in the dynamic plots and the frog call automatic identification software were also accomplished.

For education and extension purposes, a sketch book of《Who was benefited—the secrets of a giant forest house》, a brochure named《Flowers are blooming-Diary of the flowers in Taipei Botanical Garden》, and learning cards of the《Magic Babies of the Mother Nature》were published. Furthermore, six extension training activities were held.

臺灣穗花杉有用成分品系選育與利用

鍾振德

臺灣穗花杉僅分布於臺灣本島南端，由於族群稀少且結實率低，被列為積極保育之本土樹種。本計畫目標主要為臺灣穗花杉區外保育，首先採集與繁殖臺灣穗花杉，再萃取葉子、癒傷組織、假種皮以及授粉滴，並以氣相層析質譜儀分析鑑定其成分。共收集三個族群分別為浸水營、大漢山與大梅溪臺灣穗花杉母樹，共採集46株母樹，依照母樹編號採集枝條進行扦插與高壓。扦插枝條選擇母樹萌芽枝條，扦插發根率不同母樹差異從0%到100%都有。母樹枝條高壓發根率為71.3%，臺灣穗花杉無性繁殖扦插與高壓兩者最佳，但高壓苗的生長優於扦插苗。採取葉子萃取分析，並與幼葉誘導之癒傷組織進行比較，結果ferruginol只有存在葉部，葉部誘導的癒傷組織並沒有發現此成分，癒傷組織主要成分為Levoglucosenone、2,5-Furandicarboxaldehyde、1,4:3,6-Dianhydro-.alpha.-d-gluco- pyranose和5-methyl-2-Furancarboxaldehyde，而此四成分並不存在於葉片中。Furfural則為三個營養系癒傷組織共有的成分。取臺灣穗花杉果實成熟時，紅色的假種皮經冷凍乾燥處理後萃取分析其成分，主要以醣類為主，D-fructose佔10.5%，D-mannose佔11.8%，D-glucose佔約0.06%，D-galactose約佔0.03%。授粉滴主要成分為肌醇(inositol)佔32.5%，D-fructose佔3.4%，D-glucose佔約7.6%，D-galactose約佔0.15%，葡萄糖酸(D-gluconic acid)0.33%。最主要臺灣穗花杉可如預期經扦插與高壓繁殖成功，可達到區外保育計畫之目標。

臺灣穗花杉母樹萌芽枝條作為扦插材料。
The coppice shoots collected from a mother tree stump were used as stem cuttings.

Collection, Culture, Breeding and Utilization of Germplasm of *Amentotaxus formosana*

Jeng-Der Chung

Amentotaxus formosana is an indigenous tree native only to the southern areas of Taiwan. It is listed as a protected species by the Taiwan government due to the scarcity of populations and low seed production. The aim of this project can be accomplished through ex situ gene conservation. First, we collected and propagated the germplasm of *A. formosana*. Second, we analyzed the components isolated from the leaves, callus, arils and pollination drops of *A. formosana* by GC-MS. To make the experiment work properly, we collected 46 mother trees of *A. formosana* from 3 habitats of the species, Chingshuiyin, Dahan Mountain and Damei river through cutting as well as air-layering approaches. For the cutting experiment, we selected the coppice shoots of the mother tree stump for stem cuttings. The result showed that the rooting percentages are from 0 to 100% in different mother trees. Using air-layering, the mean rooting percentage of mother trees was 71.3%. Of all the experiments we tried, both cutting and air-layering seemed to be satisfactory, however, compared to cutting, most air-layered plants could grow better quality sapling. Moreover, through the analysis of components, callus induced from in vitro leaf and leaves were different. Thus, the results indicated that ferruginol was only found in leaves, but not in callus. On the other hand, levoglucosenone, 2,5-furandicarboxaldehyde, 1,4:3,6-dianhydro-.alpha.-d-glucopyranose, 5-methyl-2-furancarboxaldehyde, were only found in callus, but not in leaves. However, furfural could be found in both leaves and callus. Furthermore, the main carbohydrate components isolated from arils were D-fructose (10.5%), D-mannose (11.8%), D-glucose (0.06%) and D-galactose (0.03%). The main carbohydrate components isolated from pollination drops were inositol (32.5%), D-fructose (3.4%), D-glucose (7.6%), D-galactose (0.15%) and D-gluconic acid (0.33). Most *A. formosana* plants, as we expected, could be propagated by cutting and air-layering

臺灣穗花杉高壓發根苗木生長良好。
A plant derived from air-layering grew well.

牛樟種子苗育苗造林體系之建立

楊正釧

牛樟 (*Cinnamomum kanehirae* Hay.) 是最被看好的臺灣原生造林樹種，其用材更是生產牛樟芝的必然材料，然其野生種子採獲極不易，且種子的生產控制、採收、處理、發芽方法與最佳儲藏條件卻仍未被正式研究發表過，無法藉由適當的種子儲藏作業來達到育苗作業上的調節供需，又常因發芽技術無法掌握而影響到其育苗率。本計畫目的為：(1)生產牛樟優良種子及增加產量的技術方法。(2)牛樟果實採收及種子處理的最佳方法。(3)牛樟種子具有相當程度的休眠，研究並提供快速解除其休眠的技術方法，使播種後能在短期內整齊發芽，以降低育苗成本並提高育苗率。(4)牛樟種子的最佳儲藏條件，使種子可達其最大儲藏壽命，以調節育苗供需。(5)牛樟種子苗省工育苗體系。(6)牛樟實生苗與扦插苗之比較造林試驗。結果顯示：(1)水選可以有效淘汰輕粒及空粒的牛樟種子。(2)切割處理、藥劑處理、低溫層積處理對解除種子休眠均具有效應，但以藥劑處理為佳，可以立即解除牛樟種子之休眠性，隨時可以進行育苗作業。(3)牛樟種子苗成長快速，在本研究所發展的牛樟種子苗省工育苗作業中，於臺北苗圃栽植3個月後平均苗高可達15cm，栽植9個月後平均苗高可達66cm。(4)於太麻里研究中心進行的牛樟實生苗與扦插苗之比較造林試驗中，顯示栽植造林種子苗的造林表現明顯優於扦插苗，栽植造林經6個月後，扦插苗死亡率高達52.1%，而種子苗明顯較低，但也有15.4%的死亡率。

牛樟種子苗。
Seedlings of *Cinnamomum kanehirae*.

Establishing a Seedling Cultivation and Afforestation System of *Cinnamomum kanehirae* Hay.

Jeng-Chuann Yang

Cinnamomum kanehirae Hay. is a native species with great potential for afforestation in Taiwan, and its wood of *C. kanehirae* can be used to cultivate a high-valued fungus, *Antrodia cinnamomea*. Wild seeds of *C. kanehirae*, however, are really difficult to collect; in addition, the entire research on seed production, seed collection, seed handling, germination methods, and the optimal storage conditions of this species, has not been formally published yet. Thus, it is not workable to satisfy seedling demand and supply by applying appropriate seed storage. Still, the germination technique is not easily available so as to affect the growth rate of the seedling of this species. The goals of this study are: (1) to establish a procedure to produce seeds of *C. kanehirae* in good quality and quantity; (2) to offer the optimal method of fruit collection and seed handling of *C. kanehirae*; (3) to give a method for breaking seed dormancy in order to quickly germinate after sowing as well as to decrease the cost of seedling cultivation and increase the seedling growth rate of *C. kanehirae*; (4) to find out the optimal seed storage conditions and estimate the best longevity in order to regulate seedling demand and supply of *C. kanehirae*; (5) to efficiently establish seedling cultivation system of *C. kanehirae*; and (6) to compare growth performances of seedlings and cutting propagation of *C. kanehirae* for afforestation. Here are the results. (1) Seed selection by water is able to efficiently remove light and empty seeds of *C. kanehirae*; (2) Scarification, chemical treatment, and stratification are workable when breaking seed dormancy. Among them, chemical treatment is the best because it enables seeds of *C. kanehirae* to break dormancy quickly and the seedlings to be cultivated soon; (3) Seedlings of *C. kanehirae* show fast growth. In this study, the seedling cultivation with a lower labor cost is developed. The average height of seedling from the Taipei nursery for 3 months is up to 15 cm. After 9 months, the average height of seedling reaches 66 cm; (4) In the experiment conducted in Taimalee Research Center to compare seedling cultivation with cutting propagation of *C. kanehirae*, the afforestation performance of the seedling cultivation is better than that of cutting propagation. After 6 months of afforestation, the mortality of cutting propagation is up to 52.1%. The seedling cultivation significantly displays the low death rate but its death rate still reaches 15.4%.

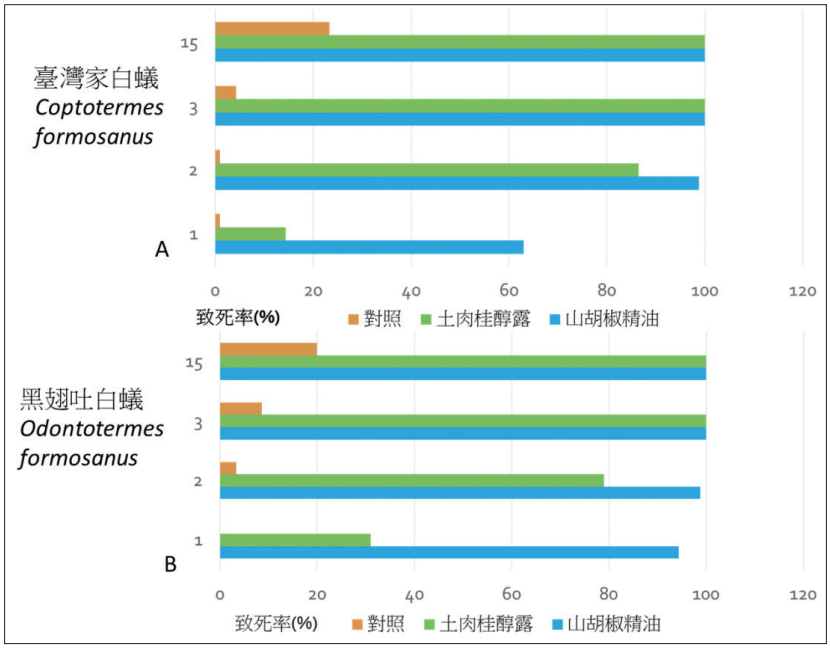
藥用植物種源蒐集及利用

李沛軒

林試所蓮華池試驗林內森林生態保存完整，具藥用潛力的植物達4百餘種，日治時期(1918年)即設立藥用植物栽培試驗地。本計畫基於臺灣中低海拔地區天然林長期開發及改變土地用途，具藥用潛力之植物資源嚴重流失，急需設置野外基因庫進行區外保育，並進行藥用植物亮點物種種原蒐集、保存及經營管理。本計畫篩選已經過科學研究驗證具有某些藥效化合物的原生植物，收集其種原，並建立野外基因庫。工作項目包括：調查收集原生藥用植物、設置藥用植物野外基因庫、進行物種培育、種原生態監測、園區維護管理、以及評估原生藥用植物在病蟲害防治之應用。

從40篇科學文獻中收集與分析45種物種的各種藥用效果，如：抗氧化、抗發炎、抗菌、抗蟲、細胞毒性等多項效用，其中以抗蟲、抗菌、細胞毒性等可能用於天然抗病蟲害的物種，其中僅有山胡椒同時具有這3種效用，而石苓舅與賊仔樹僅具抗蟲作用。山胡椒的果實抽取精油以及土肉桂葉萃取液對兩種白蟻都有很好的防治效果，在3天內皆會造成兩種白蟻100%的死亡率。本計畫亦進行肉桂醛型與枏羅木醇型土肉桂精油的化學分析，利用氣相層析分析與氣相層析質譜分析之兩種方法，得出肉桂醛型土肉桂精油成分，以*trans*-Cinnamaldehyde(桂皮醛)最高，佔54.13%，此種化合物有抗菌、殺蟲之功效；另一枏羅木醇型土肉桂精油成分，以Linalool(芳樟醇)最高，佔93.3%，此化合物可作香料。本計畫另一重點，對於藥用植物園中栽植樹木進行物候監測，以瞭解其開花結果季節，便於掌握其確切果實成熟時期。調查結果兩年之物候大致相似，這兩年氣候短期的變化，似乎對於其物候影響甚小。

由以上計畫研究成果可知，山胡椒與土肉桂為試驗有抗病蟲害之樹種，而石苓舅與賊仔樹是具有抗病蟲害之潛力，有相關的研究成果，值得持續關注。



土肉桂純露、山胡椒精油與對照組處理之臺灣家白蟻(A)與黑翅吐白蟻(B)之致死率(%，橫軸)及處理天數(縱軸)。

The leaf's extract of *Cinnamomum osmophloeum* (green bar), the fruit's essential oil of *Litsea cubeba* (blue bar), and the control (orange bar) treated with the two termite species of *Coptotermes formosanus* (Fig. A) and *Odontotermes formosanus* (Fig. B). The X axis is the lethal rate (%), and the Y one is the treatment days.

Collection and Utilization of Medicinal Plant Species

Pei-Hsuan Lee

The ecology of experimental forests managed by Lienhuachih research center of TFRI is well-protected, and there are up to 400 species of plants with medicinal potential. In the Japanese occupation period (1918), a medicinal plant cultivation experiment was established. Today, we based the protection of potential medicinal plant species on the premise that long-term development of natural forests and change in land use is threatening these resources. It's urgent to set up field gene banks for conservation and to collect and preserve the highlights of medicinal plants and to manage the cultivated garden. The work's includes: collecting native medicinal plants, managing garden of medicinal plants, ecological monitoring, and selecting applicable species for pest control.

We found from 40 references of scientific researchers that 45 species are potentially useful to have several medicinal utilities, including anti-inflammatory, anti-bacterial, insect-resistant, cytotoxicity, anti-cancer, and disease-resistant…etc. The utilities for insect-resistant, anti-bacterial, and cytotoxicity may be engaged by natural species for pest control, for examples: Litsea cubeba (Lour.) Persoon. (three utilities), *Glycosmis citrifolia* (Willd.) Lindl. (insect-resistance), and T*etradium glabrifolium* (Champ. ex Benth.) T. Hartley (insect-resistance). In an anti-termite experiment, the fruit essential oil of *Litsea cubeba* and the leaf's extract of *Cinnamomum osmophloeum* Kanehira could result in 100% kill in 3 days to two species of termites. In chemical analysis, we used GC/MS to learn about the compounds in two varieties of *C. osmophloeum*. The major ingredients are *trans*- cinnamaldehyde (54.1%) in *C. osmophloeum* ct. *cinnamaldehyde* and linalool (93.3%) in *C. osmophloeum* ct. *linalool*. The first compound could serve anti-pest utilities, and the second one could be a spice. The other point in this project is to monitor the cultivated plants in medicinal garden to understand the flowering and fruiting seasons. The monitoring results in the two years (2015~16) were similar, and therefore short-term climate changes may less affect plant's phenology.

The conclusion in this project is that *L. cubeba* and *C. osmophloeum* are the anti-pest species of choice. *Glycosmis citrifolia* and *Tetradium glabrifolium* could be potential insects and bacteria resistant chemical sources.

以毛狀根與細胞培養生產高經濟價值之二次代謝物

張淑華、何政坤、蔡錦瑩、陳媜

喜樹鹼主要來自喜樹與青脆枝，經半合成製成的藥物，可用以治療多種癌症，全球喜樹鹼及其衍生物的產值高達20億美金以上。高三尖杉酯鹼可治療白血病，只存在於生長緩慢的粗榧類植物，在美國年產值可達13億美元。利用細胞培養商業化生產植物二次代謝物已成功應用於多種植物，唯細胞培養因需長期培養在富有植物生長調節劑的培養基中，細胞很難維持穩定的生長與二次代謝物生產。植物經由轉殖野生型農桿叢根菌基因產生的毛狀根群，可以在不含植物生長調節劑的培養基自行分裂生長。可當作天然工廠，應用於生產藥物、食品調味料及其他商業產品，非常具有潛力。

本計畫建立青脆枝與臺灣粗榧之野生型農桿菌基因轉殖方法，將農桿菌AR15834，AR1600與AR1601之rol B基因轉入葉片與莖段DNA中，誘導產生轉基因毛狀根，以PCR確認農桿菌之rol B基因存在於毛狀根中，建立培養毛狀根最佳培養基組成，定期以HPLC分析檢測毛狀根的二次代謝物含量。選擇生長及喜樹鹼含量皆佳的青脆枝毛狀根WA1，進行1-L波浪式與10-L氣舉式生物反應器培養，波浪式生物反應器培養3個月毛狀根鮮重由原來的5g增加為698g；氣舉式生物反應器培養5個月，鮮重由10g增加為2896g，分別可生產79.6mg與728.2mg的喜樹鹼。粗榧毛狀根C5於液體培養生長良好，三角瓶培養30天鮮重由0.2g增加為0.74±0.05g，2-L氣舉式生物反應器培養3個月鮮重由5g增加為284g。

青脆枝毛狀根培養於10-L氣舉式生物反應器。
Hairy roots of *Nothapodytes nimmoniana* cultured in a 10-L airlift bioreactor.

Transgenic Hairy Root and Cell Cultures for Production of High-Value Secondary Metabolites

Shu-Hwa Chang, Cheng-Kuen Ho, Jin-Yin Tsay, Jung Chen

Several medicines converted from Compatothecin (CPT) via semi-chemical synthesis have been proven to cure many cancer diseases. The global market of these drugs reaches more than 20 billion US dollars a year. Homoharringtonine (HHT) found in slow growing *Cephalotaxus* species, has proven to be an effective drug to cure leukemia cancer. The USA market of these drugs reaches 13 billion US dollars a year. Cell cultures have been successfully used to produces metabolites in many plants. However, they are not stable for maintaining in long-term subculture medium containing plant growth regulators. Hairy root transformed with *Agrobacterium rhizogenes* grew rapidly in hormone free medium and potentially acted as natural factories to produce medicines, food flavoring, and other commercial products has been reported to be a potential alternative. Stable production of alkaloids from hairy roots as compared to cell cultures has been dressed especially by many researchers.

Hairy roots system of *Nothapodytes nimmoniana* and *Cephalotaxus wilsoniana* transformed with wild strains of *A. rhizogenes* were established in this project. Hairy root lines transformed with *A. rhizogenes* strains AR15834, AR1600, and AR1601 were confirmed by using PCR to identify the existence of rol B gene. Contents of secondary metabolites were determined regularly using HPLC. Root line #WA1 with great growth and camptothecin (CPT) derived from *N. nimmoniana* cultures were cultured in a 1-L wave bioreactor and a 10-L lift bioreactor. After 3 month in culture, fresh weight of roots in wave reactor reached 698g from 5g of initial inoculum, while lift reactor obtained 2,896g from initial 10g. They produced 79.6 and 728.2mg CPT, respectively. Hairy root line #C5 of *C. wilsoniana* grew well in flask with liquid medium, which obtained 0.74±0.05g of fresh weight from initial 0.2g. When culturing in a 2-L lift reactor for 3 months, root weight were 284g from 5g of initial weight.

生物技術應用於植物種質的保存

張淑華、何政坤、蔡錦瑩、陳媜、吳家禎

利用低溫與超低溫冰凍保存法保存林木種質，可大幅減少組織培養之繼代培養次數、培養空間，並可長期保存種質的活力，低溫保存係利用培養基添加生長抑制劑、組合光照與低溫(4℃與12℃)培養條件，來降低生長，延長繼代培養的時間。超低溫冰凍保存則將培養物利用護凍劑、藻膠包埋後，於液態氮(-196℃)中進行保存。另一目的在將牛樟芽體與體胚製成人工種子，以克服組培苗出栽馴化的困難，降低育苗成本。低溫與超低溫保存方面，以轉基因臺灣紅豆杉細胞與具優良性狀之牛樟芽體為材料，共培育36個培養轉基因臺灣紅豆杉細胞株與並定期進行二次代謝物含量調查，其細胞生長與紫杉烷類含量穩定。將轉基因臺灣紅豆杉細胞置於低溫與超低溫保存，低溫保存2年紅豆杉細胞可恢復生長，超低溫保存則將細胞需先於4℃培養培養2-3週後，經藻膠包埋移入超低溫才能存活。牛樟營養系#F5、#T4與#D3芽體進行低溫保存，1.5cm大小莖芽最適合作為低溫保存材料，培養基與預冷處理可提高芽體存活率，保存於12℃的芽體存活率(86.7%)略高於4℃ (83.3%)。另外完成牛樟造林表現佳、組培繁殖率高、唯出栽困難品系B77與B78試管芽體的增殖與抽長試驗，各培育250個以上莖芽，芽體經藻膠包埋以$CaCl_2 \cdot 2H_2O$處理10min 的保水率最高，80% 包埋芽體可於MS培養基、蛭石+珍珠石及商業培養土(圖1)的介質中，發育成具根、莖、葉的小苗。

牛樟芽體經藻膠包埋直接於溫室發育成苗。
Shoot tips embedding with alginate jelly seeding developed into whole plants nursing in the greenhouse.

The Application of Biotechnology in Germplasm Conservation

Shu-Hwa Chang, Cheng-Kuen Ho, Jin-Yin Tsay, Jung Chen, Chia-Chen Wu

The application of low temperature storage and cryopreservation on germplasm preservation in long term period could reduce both labor and storage space costs of serial subcultures in vitro, and save vitality. For cold storage, growth inhibitors in the culture medium, illumination control and low temperatures ranging from 4℃ to 12℃ are used to slow growth to prolong culturing period. For cryopreservation, cultures such as shoot tip or somatic embryos are frozen in liquid nitrogen (-196℃) by using antifreezing agents and encapsulation vitrification. Artificial seeds produced with shoot tips and somatic embryos of *Cinnamomum kanehirae* were also tried in this project. The aim is to reduce the difficult survival step of nursing plants from shoot rooting *in vitro* to plant out ex vitro. More than 36 transgenic cell lines of *Taxus sumatrana* were subcultured periodically to maintain cell viability and keep taxanes content stable. Transgenic cells treated with growth inhibitors stored at low temperature for 2 years could regain normal growth. In trials of cryopreservation, viable cells obtained after stored at 4℃ for 2-3 weeks, encapsulated, and then transfer into liquid nitrogen. Shoot tip cultures of *C. kanehirae* clone #F5, #T4, and #D3 were used in the low temperature trials. Great survival was obtained when shoot tip 1.5 cm long and precooling culture medium were used. Cultures stored at 12℃ produced a little higher survival rate than that did at 4℃ (86.7% vs 83.3%). *C. kanehirae* clone #B77 and #B78 showed greater growth in field and higher multiplication rate in tissue cultures, but they were difficult to survive when *in vitro* plantlets were out-planted in greenhouse. More than 250 shoot tip explants of two clones each were multiplied *in vitro*. Embedding those explants with alginate jelly treated with $CaCl_2 \cdot 2H_2O$ for 10 min was suitable to obtain greater water retention rate. Eighty percent of the embedding shoot tips could develop into whole plants with roots, stems, and leaves when cultured in MS medium, mixture medium composed with vermiculite and perlite, and commercial formula medium.

室內美化及空氣改善之原生植物開發與利用

Development and Utilization of Native Plants for Indoor Air Improvement and Ornamental Usage

張乃航

Nai-Hang Chang

近年來常有報導指出長期置身於密閉性的建築物內時，出現頭痛，呼吸道乾燥，嗜睡，無法專心的症狀，流行病學稱之為「病態建築症候群」。因此在室內擺放綠色植物來改善生活環境，減少壓力，降低落塵量及空氣中有機溶劑濃度等。根據目前研究結果來看，耐蔭性良好之原生植物，其主要機制要決定於氣孔關閉的多少與時間，低光下光合作用能力的高低並非唯一之條件。符合此條件樹種，以珊瑚樹幼齡樹具發展的潛力。小葉赤楠(金門種)及呂宋莢　可以種子森林的形式，以小型盆栽提供個人裝飾之用。根據耐蔭性試驗顯示，蘭嶼八角金盤耐蔭性不良，但耐旱能力較佳，可育成較大型盆栽，在較佳照明區域使用，多數紫金牛屬植物能耐較低光量一約全日照光量的10%，鐵雨傘較高一約全日照光量的30%，但耐旱能力較差，以小型盆栽發展為主，室內生長耐受性以珊瑚樹最佳，四葉蓮次之。桃葉珊瑚用種子繁殖能比較省工省資本投入，2節帶葉扦插比較能得到均一大量的苗木。

The results of plants shading experiment reveal that photosynthesis capacity of plants under low light environment would not be the only parameter for plants to adapt under low light environment. Perhaps it also depended on the capacity of stomata closing capacity, by the data collected from shading experiment. We found that *Viburnum odoratissimum* and Syzygium *buxifolium* (Kinmen line) have the potential for indoor plant usage. According to the shading experiment results, *Lanyue fatsia* could not tolerant shaded environment but did tolerant dry environment. Most *Ardisia* genus plants can tolerate shading environment of 10% sunlight, but not tolerating dry environment. The indoor cultural test revealed that the best choice is *V. odoratissimum*, while the second is *Chloranthus oldhamii*. By using the shading capacity, seed and cutting propagation methods, the dwarf bonsai of *V. odoratissimum* and *C. oldhamii* are suitable to become indoor plants.

以種子森林小型盆栽辦公桌上展示的形式栽培與繁殖。
The dwarf seedling forest bonsai horticulture methods for office desk ornamental usage.

臺灣松露之栽培與產業化研究

The Cultivation and Commercialization of Truffles in Taiwan

陳正豐、黃裕星、張東柱、林文薇、林介龍、李鎧彤、黃勁暉、傅春旭

Cheng-Fong Chen, Yue-Hsing Huang, Tun-Tschu Chang, Wen-Wei Lin, Chieh-Lung Lin, Hoi-Tung Lee, King-Fai Wong, Chuen-Hsu Fu

進行一年生青剛櫟半無菌苗之接種前檢定工作。確認這些半無菌苗根部未受其他的真菌感染。將培育完成的青剛櫟半無菌苗進行松露孢子懸浮液的接種工作。嘗試並評估各種接種方式，以找出最方便且高成功率的接種方式。接種試驗濃度：分別以1,000、2,000、4,000及8,000孢子/毫升4種不同孢子懸浮液濃度進行接種試驗。接種方式有兩種，分別為（一）以穴植盤浸泡各濃度之孢子懸浮液5分鐘的接種方式進行接種。（二）單株個別接種方式，接種各種孢子懸浮液各1毫升。目前評估結果，以穴植盤浸泡各濃度之孢子懸浮液的接種方式效果不佳，幾乎沒有發現感染的植株，平均感染比例為1.25%。以單株個別接種方式接種各種孢子懸浮液各1毫升，以8,000個/毫升的接種成功比率最高，其次為4,000，再其次為2,000及1,000；成功比率分別為22%、17%，12%及8%。完成接種的苗木則進行施肥撫育，分別以施用100天肥效之好康多、每兩星期施用花寶2號及對照組進行生長評估。發現施用肥效100天的好康多對苗木的生長效果最好。水源地苗圃內的青剛櫟菌根苗遭受小白紋毒蛾的取食，以施用好康多的苗木受害最嚴重，其次是施用花寶的菌根苗。作為對照組的菌根苗，雖然生長比不上其他施肥的菌根苗，但是明顯受害最為輕微。將完成檢定工作的菌根苗木，種植在經過酸鹼調整的松露生產園中，每三個月檢查出栽苗菌根發展情形。

Verification work was conducted by check the roots of some one-year-old semi-sterilized *Quercus glauca* seedlings to ensure that they were not colonization by other mycorrhizal fungi before the inoculation test. The semi-sterilized seedlings were inoculated by spore suspension of *Tuber indiucm*. Two inoculation methods were conducted: (1) polypaks with seedlings was soaked in different concentrations of spore suspensions for 5 min; (2) Individual plant was inoculated with a 1 ml spore supension of a variety of spore suspensions. Assessment results indicate that the mehod of polypak-soaking is ineffective, almost no mycorrizal plants were found. The average infection rate was 1.25%. By adjusting spore suspension to 8,000，4,000, 2,000 and 1,000 spores/ml, and inoculated 1 ml spore suspension on the roots of individual plant, the 8000 spores/ml inoculum had the highest success rate, followed by 4,000, 2,000 and 1,000 inocula; success rates were 22%, 17%, 12% and 8%. Mycorrhizal plants were fertilized 3 ways, one was fertilized by 100-day long-acting fertilizer, one was sprayed with diluted chemical fertilizer very 2 weeks, and one had no top dressing as control. Results of top dressing test showed that the 100-days long-acting fertilizer had the best effect on the growth of seedlings, and it was followed by the diluted chemical fertilizer spray every 2 weeks and control. The better grown mycorrhizal Quercus glauca seedlings suffered more serious small tussock moth attacks in the nursey. Mycorrhizas of Tuber sp. were checked 4 months after inoculation. The cultivation farm was prepared and adjusted the soil pH to 7. After planting, the cultivation farm was managed with respects to weeding and fertilization. And development of mycorrhizas was checked every 3-month.

松露菌根苗出栽種植。

Seedlings with mycorrhizas of Tuber sp. were planted on the cultivation farm.

高經濟林產品生產鏈關鍵技術之研發

何政坤、張淑華

生產高價值林產品的過程如南洋紅豆杉的10-DAB (歐洲紫杉醇前驅物)與土肉桂的精油與黃酮類，包括營養系繁殖、栽培、農場經營、枝葉收獲乾燥包裝，與每批次的成分分析。在這生產鏈中，有許多降低成本與提高效率的關鍵技術。對南洋紅豆杉而言，關鍵技術可能就在採穗園的經營以提供高產量的扦插發根苗，以及如何在適當季節採收枝葉以獲得高收益的10-DAB。對土肉桂而言，就可能是培養幼年化苗木以提高在農場栽培的存活與生物量，以及如何同時收獲精油與黃酮類。本計畫研究建立關鍵技術以期望臺灣產業能投資此二高經濟林作物。南洋紅豆杉臺紅3號在2014年完成技術移轉，從2012年4月在烏來信賢苗圃建立栽培區(圖左)，在2014年至2016年，大量繁殖體系包括在2014年11月大量採穗扦插，2015年3月培育軟缽苗，2016年11月培育苗高50cm共1萬株。與林務局合作，在2017年初將完成5ha供臺紅3號栽培，紅豆杉臺紅3號成功的完成從育種、繁殖、育苗、栽培的生產鏈。從肉桂醛型土肉桂葉片生產的肉桂醛純露的栽培區(圖右)與生產技術，在2016年7月經財團法人農業科技研究院評估為適合商品化的技術，依據農科院的評估：純露用在沙士飲料的產值可達3,500萬元以上，用在家禽飼料業的產值在7,600萬元以上。具有商品價值的純露雖然含有香豆素2ppm以下，符合衛福部規範的安全濃度。但飲料業與動物飼料業為食安考量，要求純露的香豆素為零檢出。我們選拔出2肉桂醛型品系在蓮華池建立7個月的栽培區，在栽培期間取葉片分析，香豆素都零檢出，我們將採收葉片製造純露生產無香豆素的純露，達成技術移轉。

南洋紅豆杉臺紅3號(左)與肉桂醛型土肉桂(右)栽培區。
Cultivation farms of *Taxus sumatrana* “Taiyew No.3” (left) and *Cinnamomum osmophloeum* ct cinnamon (right).

Study on Key Techniques in the Production Chain of High Valued Forest Products

Cheng-Kuen Ho, Shu-Hwa Chang

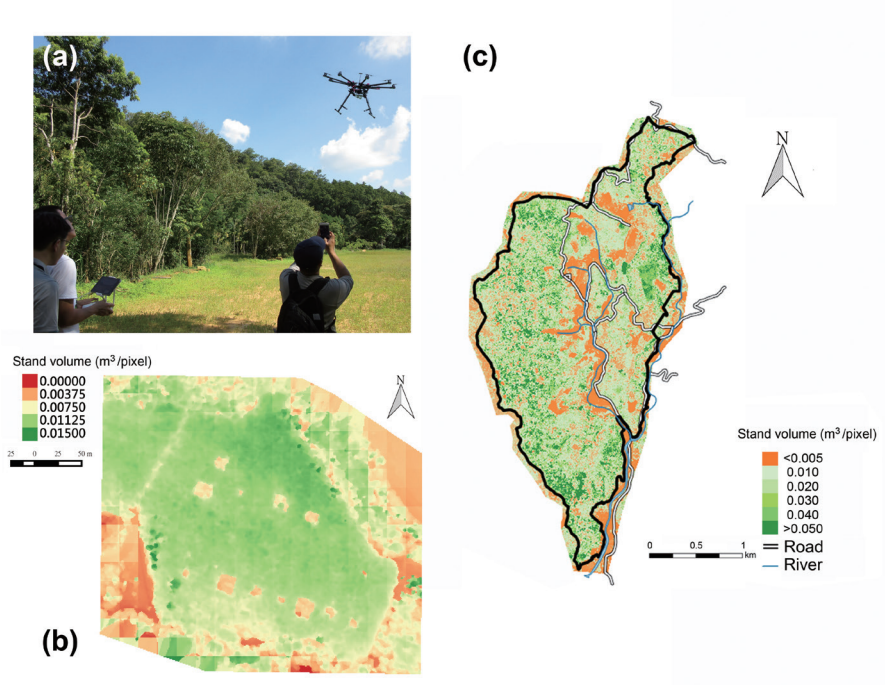
The production processes of valuable forest products such as 10-DAB (a precursor of docytaxel) in *Taxus sumatrana*, essential oils, and flavonoids in *Cinnamomum osmophloeum* include clonal propagation, cultivation, farm management, branch harvest, drying, packaging, and constituent analysis for every batch. In this production chain, there are major key techniques to lower cost and increase efficiency. For *T. sumatrana*, the key tech might be the scion garden management to produce mass cuttings to supply a great amount of rooted cuttings, and how to harvest at suitable season to obtain the greatest yield of 10-DAB. For *C. osmophloem*, it might be how to supply juvenile plants to enhance the survival and biomass in a farm, to harvest both essential oils and flavonoids in one step. This project is trying to establish the key techs so that companies in Taiwan may invest in these two valuable forest crops. The variety of *T. sumatrana* 'Taiyew No.3', a 10-DAB rich variety, was licensed to a biotech company in 2014. We established a cultivation farm at Shinshan, Wulai in Apr 2012. During the period from 2014 to 2016, the mass propagation including rooting cuttings beginning in Dec 2014, transplanting into pots in Mar 2015, and growing ten thousand potted plants up to 50cm high in Nov 2016 was accomplished. An area with 5ha of forest land provided by Taiwan Forest Bureau will be ready for planting Taiyew No.3 in early 2017. Cuttings produced scions from this garden were contracted to support the requirement of Taxus cultivation. The production chain for Taiyew No.3 has successfully constructed. The commercial products of cinnamon hydrosol made from leaves of *C. osmophloeum* ct cinnamon was established (Fig. 1) and the production chain was evaluated by Agricultural Technology Research Institute (ATRI). It was estimated that the market of hydrosol in sarsaparilla drinks will reach more than 35 million NT dollars and in poultry feed will reach more than 76 million NT dollars. The hydrosol contained less than 2 ppm of coumarin, a minimum concentration allowance announced by Ministry of Health and Welfare. Non-detectable level of coumarin is requested by beverage industry. We selected two varieties and planted them at Lianhuachi Research Center, Taiwan Forestry Research Institute, for 7 months this year. The leaves were sampled and no coumarin was found. We will harvest leaves in March next year and produce coumarin-free hydrosols, these varieties and products will be licensed to beverage industries.

應用遙測於推估人工林生產力技術之建立

鍾智昕、邱志明

評估森林的林分特徵、蓄積量與結構，是森林經營、育林撫育與林產收穫的決策要件。遙測可提供有效率、大範圍與精確的森林屬性地圖資料，可減少地面調查人力、金錢與時間的耗費。近年來，新一代的Landsat8影像與無人機系統，提供更良好的影像品質與超高解析度影像，國內目前於林業相關應用較少。

本研究針對山地與平地區域人工林，以臺灣中部蓮華池研究中心試驗林、東部花蓮大農大富平地森林園區與西部雲林崁腳杜英(*Elaeocarpus sylvestris*)造林地為研究對象，計算造林地林分特徵、結構與蓄積量，並結合遙測指標包括NDVI、SAVI與光譜混合分析之端元(endmembers)分量，建立各項指標與林分特徵的回歸推估式，嘗試繪製林分蓄積量地圖。結果顯示：1.依地面樣區調查資料，推估蓮華池造林地的平均蓄積量約為209.1m^{3}ha^{-1}(sd=96.5)，各遙測指標以光譜混合分析的陰影分量所建立之迴歸模式推估最佳，推估平均蓄積量為192.7m^{3}ha^{-1}(sd=119.6)，遙測推估的材積量約低估7.8%。2.花蓮大農大富平地森林園區依現地監測樣區調查資料，推估約1,000公頃10餘種闊葉樹混合之平地造林的平均蓄積量為21.7m^{3}ha^{-1}(sd=6.3)，各遙測指標以光譜混合分析的綠色植生分量所建立之迴歸模式推估最佳，平均蓄積量為24.3m^{3}ha^{-1}(sd=8.3)，遙測推估的材積量約高估11.9%。3.由疏伐樣區推估之杜英造林地平均蓄積量為126.5m^{3}ha^{-1}(sd=3.1)，以無人機空拍所獲取的樹冠高程模型推估之造林地平均蓄積量122.5m^{3}ha^{-1}(sd=5.3)，整體而言約低估3.2%。使用遙測技術推估的林分蓄積量，可能產生高估與低估的結果，但可作為建構大尺度林分基礎地圖的工具，提供作為人工林永續經營管理的參考。



(a)無人機系統應用於林地調查現況。(b)無人機系統空拍推估雲林杜英造林地蓄積量分布圖與。(c)以Landsat 8影像推估蓮華池研究中心蓄積量分布圖。(1 pixel= 1 m^2)

(a) Inventory of forest areas using an unmanned aerial system. (b) Application of unmanned aerial system and photogrammetry to estimate the growing stock of *Elaeocarpus sylvestris* plantation in Yunlin County. (c) Application of Landsat 8 image data to estimate the growing stock of plantation in Lienhuachih Research Center. (1 pixel= 1 m^2)

Application of Remote Sensing to Estimate Plantation Productivity

Chih-Hsin Chung, Chih-ming Chiu

The assessment of stand characteristics, volume, and structure are of high interest and very important to decision making in forest management, silviculture and timber production. Remote sensing can provide high efficiency, large scale and accuracy for mapping stand attributes. It has the capacity to characterize forest information to reduce cost of labor, money and time. In recent years, the Landsat 8 satellite images and the small unmanned aircraft system (UAS) are providing innovative quality and ultra-high resolution images of remote sensing. However, use of the new remote sensing technologies to apply to forest management and mapping is limited in Taiwan.

The goals of the project are to analyze the stand characteristics, structure and to mapping volume distribution for sustainable plantation management. To achieve the goals, one mountainous and 2 farm plantations in central (the Lienhuachih Research Center), eastern (the forest park in Hualien County) and western (the plantation in Yunlin County) in Taiwan were selected to investigate the stand DBH, tree height, and volume. The relationship between stand properties and remote sensing index (NDVI, SAVI and spectral mixed analysis) were analyzed then, in order to mapping varying stand properties. The main results are as follows: (1) For the central site (Lienhuachih Research Center), the mean plantation stand volume from field surveys data is $209.1 m^3 ha^{-1}$ (sd = 96.5). Choosing the best regression model by using the shadow endmember of spectral mixed analysis with Landsat 8 image for estimating the mean plantation stand volume from field surveys data gives $192.7 m^3 ha^{-1}$ (sd = 119.6). It underestimates about 7.8% from satellite remote sensing data; (2) For the eastern site (the forest park in Hualien County), it is a mix broadleaves species plantation about 1,000 ha, the mean plantation stand volume from field surveys data is $21.7 m^3 ha^{-1}$ (sd = 6.3). Choosing the best regression model by using the vegetation endmember of spectral mixed analysis with Landsat 8 image for estimating the mean plantation stand volume from field surveys data is $24.3 m^3 ha^{-1}$ (sd = 8.3). It overestimates about 11.9% from satellite remote sensing data; (3) For the western site (the *Elaeocarpus sylvestris* plantation in Yunlin County), the mean plantation stand volume from thinning plot data is $126.5 m^3 ha^{-1}$ (sd = 3.1). Choosing the best regression model by using the canopy height model for UAS for estimating the mean plantation stand volume from field surveys data is $122.5 m^3 ha^{-1}$ (sd = 5.3). It underestimates about 3.2% from UAS data. Mapping of stand volume using satellite or UAS remote sensing data thus may result in over- and underestimation, but it can provide advantageous in forest of large area. Then the map can provide important information for sustainable management of plantation ecosystem.

私有林及小規模林業之組織營運模式研究

Study on the Organizations and Operations of Small Scale Private Forestland Owners

王培蓉

Pei-jung Wang

臺灣私有林地面積約50萬公頃，佔總森林面積24.1%，且在環保趨勢與木材資源日益匱乏的籲求下，私有林將扮演木材生產的重要角色。臺灣私有林之林地面積大多在2公頃以內，難以擬訂長期健全的經營管理計畫，須透過集團化、組織化方式，以擴大生產或作業規模並低經營成本與風險。

林業合作社可概分為：資訊合作、設備合作、財務合作及經營合作等四種類型。依實務運作檢視：1940年代前的林業合作組織偏向經營與財務合作，至1990年代後則較著重於資訊與設備的合作。本研究以農林漁牧普查資料為母體，進行林業合作組織意願調查，經問卷統計結果發現：臺灣無組織化的個別林農佔99.2%，超過七成林農從未由林業獲得收入。由於林農人數龐大，面積小、異質性高，在營林過程投入大量資金，但無法預期未來收益。對組織化雖有需求，個別林農卻因營林目標的不同，而難以結合。研究也發現：私有林主對相互交流與專業諮詢管道不足，不到六成受訪者有意願參與合作社，實有必要加強專業輔導。

為提振私有林經營及組織成效，本研究參考FAO提出的人工林經營之指導方針、日本的林業補貼制度，以及森林融資的國際概念與作法，以提供私有林輔導之參考。

小私有林主的面積小，不利經營。
Small scale forestland owners only have small areas to work with, which makes it hard to operate.

The private-held forestland area in Taiwan is 500,000 hectares, which makes up 24.1% of the total forestland in Taiwan. Given the eco-friendly trend and decreasing sources of timber, the private woodlots have an important role in timber production. A majority of Taiwan's private woodlot holdings are less than 2 hectares, which makes it difficult to draw up a long-term, sound management plan. Only through collective management or organization can we expand the scale of production or operation and lower the management cost and risks.

Forestry cooperatives can integrate small-scale farmers to promote their co-operation in information, equipment, finance and management. A review of the actual practices indicates two trends in how forest cooperatives work: more emphasis on the cooperation in management and finance before 1940s; more emphasis on the cooperation in information and equipment after 1990s. Based on the analysis from the agriculture, forestry, fishery, and animal husbandry censuses, this study conducted a survey on the willingness for collaborative forestry management. The survey results indicate the following findings. Individual forest farmers without participating in any organization account for 99.2%. Among them, more than 70% of the forest farmers have never made their income from forestry. Due to an overwhelming population and small size of woodlots, the heterogeneity of forestry farmers is high. In addition, the big capital investment in forestry management does not guarantee any returns. Furthermore, despite there is a need for organization, individual farmers find it hard to collaborate with different goals in mind. The research also points out it is indispensable to enhance professional assistance because less than 60% of the questionnaire respondents are willing to join a forestry cooperative as a result of lack of exchanges in the industry and lack of professional consulting channels.

To promote the effectiveness in private forestland management and organization, this study draws upon the guidelines for plantation management by FAO, Japanese forestry subsidizing system, and forestry financing with reference to international concepts and practices to provide advice for private forestland assistance.

林業國家標準研訂與能力建構

Establishment and Capacity Building of National Forestry Standards

林俊成

Jiunn-Cheng Lin

本研究針對造林地疏伐作業、造林地修枝作業、景觀樹木修剪作業、樹木健康/風險評估及森林生態系服務(碳匯)評估加以研訂其規範或評估內容。本計畫將林業研究成果，參照目前標準法第七條規定國家標準制定程序的精神，先進行資料收集與分析，藉以研擬出草案內容，再召集相關專家學者共同來討論及修正，最後據以擬定林業相關技術規範及評估標準內容。未來可推動到各地方政府，若地方政府也認同並遵行，則可再進一步推廣到民間行業，視需求再評估可列為國家標準或行業標準。

This project aims to establish rules or assessment standards, and to build capacities for not only plantation thinning and pruning, but urban forest transplanting and pruning. A further goal is to evaluate the assessment methods of tree health/risks and ecosystem service functions (carbon sink) within the next two years. Based on article 7 of current Regulation Standard Act which stipulates the procedures of the national standard establishment, this project will use forestry research results to conduct data collecting and analyses for drafting a proposal. Following that, we will draw on experts and scholars in related fields for discussion and revision to finally establish rules for forestry-related techniques as well as assessment standards. It is hoped to extend these practices to local governments and if accepted, then to private trades. An advanced assessment will be undertaken if there's a need to make them standards for either the entire nation or private trades only.

主幹截剪（直徑不可超過10公分）的三切法。
Tree-cut method for reduction cut from trunk (diameter < 10cm)

臺灣森林永續認證制度建構之研究

Study on Establishing Sustainable Certification System for Forests in Taiwan

林裕仁

Yu-Jen Lin

本計畫目的在透過制訂符合國際森林認證精神與標準，且適用臺灣森林環境與管理現況之認驗證準則與指標，逐步推展國內林地通過國際森林經營驗證，以提昇國內公私有林森林經營與木材產品與非林木產品之國際競爭力。計畫執行期間共計輔導2家國有林租地民間造林業者完成所經營林地通過國際森林認證系統森林經營管理FSC™ FM驗證合格實務案例。並以此輔導國有林租地造林業者之成功經驗，協助本所蓮華池研究中心申請驗證，接受嚴苛的驗證稽核考驗，進一步成功取得臺灣地區第一張國有林國際FSC™森林管理驗證合格證書，成為國內國有林未來經營之標竿，並於105年11月8日舉辦該合格證書之頒證儀式，同時舉辦「國有林森林認證研討會」，以成功取得合格證書之經驗，推廣其他國有林管理單位積極申請通過國際森林驗證系統，提高國有林經營效率。

To promote the effects of forest management and to increase competitiveness for timber and non-timber products, the objects of this study are to first draw up a standard with criteria and indictors of forest certification for forest management, and second gradually to develop forest certification of forest management using the standards. However, the process during the standards drawing has to simultaneously follow the spirit and regulation of international forest certification system; the final standards shall be feasibly to the current forest status in Taiwan and can be carried out in practice. The works of this project during the term had assisted 2 private forest companies successfully getting the FSC™ FM certification. Furthermore, based on the successful assistant experiences to the two private forest companies obtaining the FSC™ FM certifications and under many efforts of this project implement, the Lienhuachih Research Center, the Taiwan Forestry Research Institute, also successfully obtained the FSC™ FM certification, which is the first FSC™ FM certification for state-owned forests in Taiwan. This first FSC™ FM certification will become a benchmark of state-owned forests management. The certificate ceremony was held on Nov. 8, 2016. To promote more state owned forests to apply for the certification, to pass the auditing smoothly, and to enhance its forest management efficiency, a conference with the title: “Forest certification for state-owned forests” was held on the same day.

都市林危險樹木的檢查及診斷之標準程序建立

Standard Operating Procedure of Urban Hazard Tree Inspection and Diagnosis for Tree Risk Assessment

林柏亨、林振榮

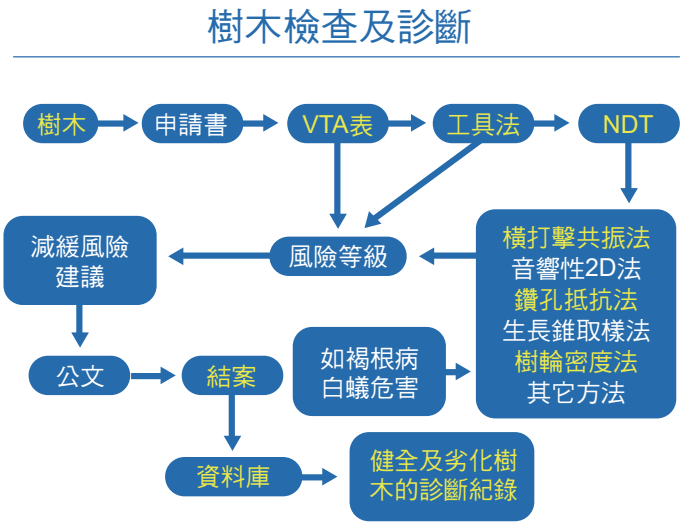
Po-Hun Ling, Cheng-Jung Lin

本計畫目的在目視調查常見不同樹種的樹木危險缺點項目，配合檢測樹木儀器的實施，收集文獻資料制定危險樹木的等級及風險評估的標準，協助培訓樹藝師，無損技術應用樹齡的檢測及評估。

完成臨床檢查樹木共有50樹種合計1,270株，以作為目視樹木外觀檢查及儀器檢測的規範參考，建立樹木管理規範參考。配合樹木醫學教育學程，及樹木檢查示範記者會共8場。完成10種樹種的年輪檢測及樹齡評估，已完成輔助人工專業樹輪辨識軟體來檢測樹輪及評估樹齡。

The purpose of this project was to investigate the seven hazard items from different tree species by visual tree assessment. Tree trunk was inspected by stress wave and drilling resistance non-destructive techniques (NDTs) for understanding its wood decay status. The tree hazard grades and risk assessment grades are built by a reference method. Moreover, to educate tree doctors for detecting tree health grades by standard operating procedure. The tress wave 2D tomography was used for understanding the tree trunk health grades and the drilling resistance method was used to understand the decayed position and degree. Thus the standard operating procedure for assessing tree health grades was established.

The project completed a total of 50 species and 1,270 trees and established visual shortcomings of the seven major tree structures by visual tree assessment (VTA). A total of 700 trees were detected by 2D stress wave nondestructive technique (NDT). The plan has been completed to check the trees' objectives by VTA and NDT. For the most serious risk level, it is recommended to reduce the risk by tree treatments. Termites and decay are the main causes of tree damages, for which prevention and management is recommended.



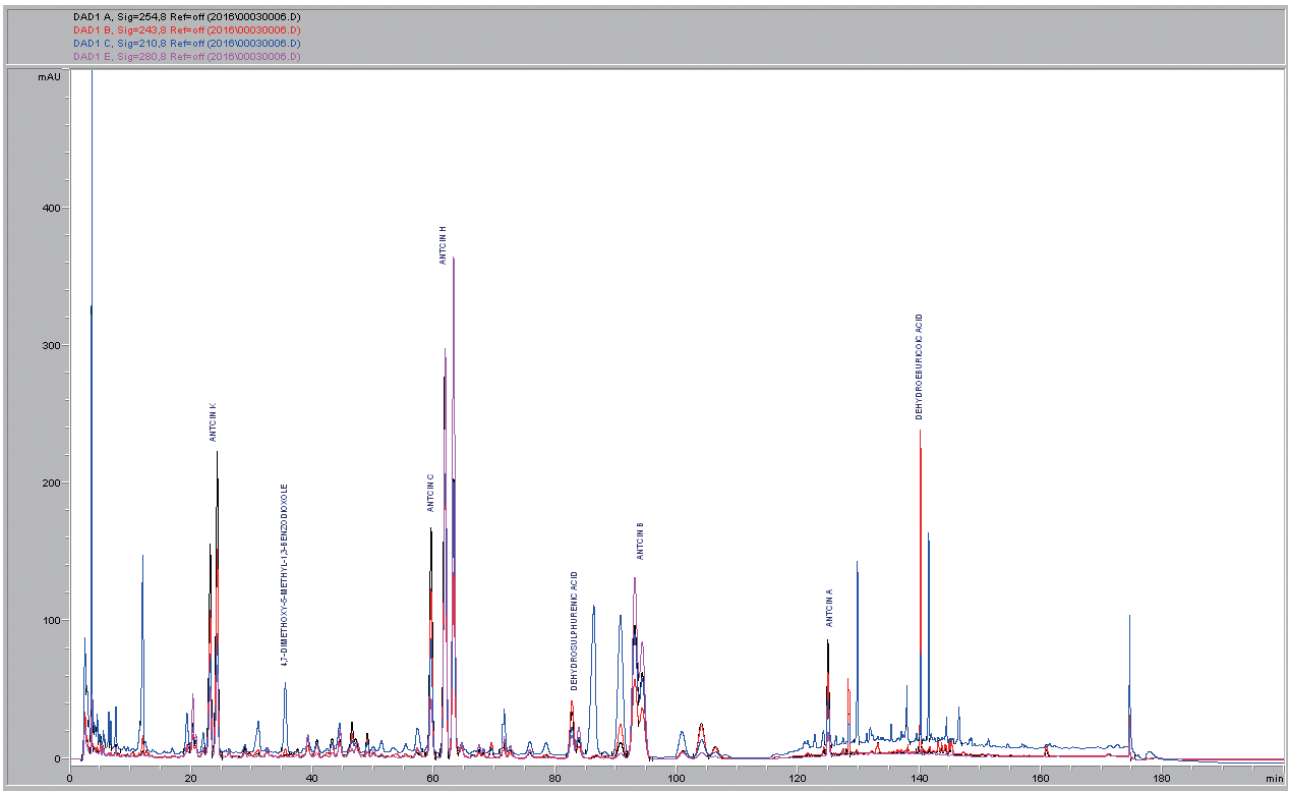
應用目視樹木評估法及非破壞性技術檢測樹木危險性的標準程序流程。

The SOP flow of tree hazardous detection and assessment in living tree by visual tree assessment and nondestructive techniques.

森林中食藥用菇類的開發利用及種源保存

張東柱、傅春旭

牛樟菇為臺灣特有種藥用真菌，至目前為止已有500多篇碩博士論文及300多篇發表於國際期刊論文。牛樟菇的研究成果顯示具有多方面的生物活性，已成為臺灣具有開發潛力及國際競爭力之生技產品原料。牛樟菇在自然界僅寄腐生於臺灣特有種樹木牛樟木材，因此一般民眾相信只有生長在牛樟木上的牛樟菇才具有藥用價值。但並沒有研究顯示栽培在牛樟木上的牛樟菇在成分上有其特殊性。本研究以臺灣多種木材培養牛樟菇，其中在牛樟、樟樹、右樟、杉木、香杉及柳杉等木材可形成子實體，分析這6種樹木木材上產生牛樟菇體的成分差異。在質的比較方面選用八種野生牛樟菇的指標成分，其中五種為牛樟菇菇體特有成分(Antcin A，B，C，H，K)及牛樟菇菇體與菌絲體三種共有成分(4, 7-dimethoxy-5-methyl-1, 3-benzodioxole, Dehydrosulphurenic acid及Dehydroeburicoic acid)，在量的比較方面，以95%酒精經由三次迴流萃取，經由烘乾後測定酒萃含量。採取部分酒萃物進行HPLC分析以檢測八種指標成分的出現情形。結果顯示上供試6種木材產生之牛樟菇子實體皆含有八種指標成分，這6種菇體的酒萃含量都高於24%，其高低順序分別為樟樹≒牛樟>香杉>右樟>杉木>柳杉，此結果顯示牛樟菇的主要生合成途徑不因生長木材不同而有差異，但是否存在個別不同生長基質有不同的代謝途徑有待進一步研究。在其他菇類資源調查中，也獲得一些具潛力之食藥用菇類如靈芝、桑黃及蟲草類。



野生牛樟菇之HPLC圖譜，含有8種指標成分。

The HPLC chromatogram of wild *Antrodia cinnamomea* basidiome, the eight indicating components are indicated.

Utilization and Cultural Preservation of Edible and Medicinal Mushrooms from Forests

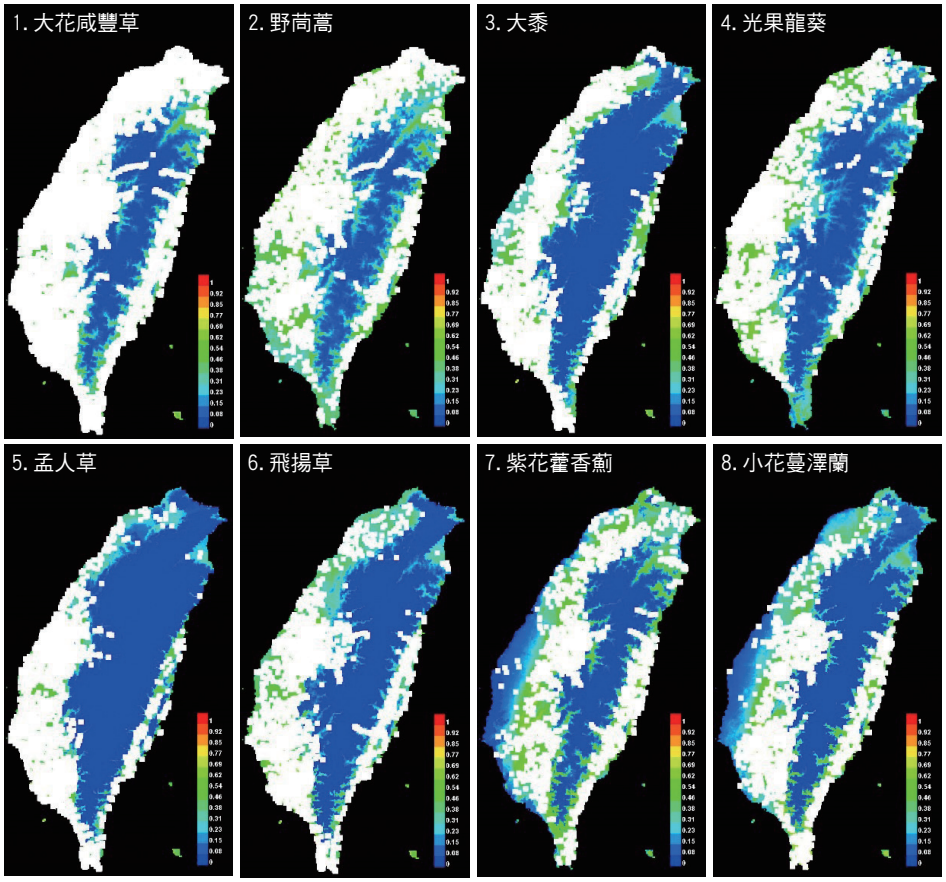
Tun-Tschu Chang, Chuen-Hsu Fu

Antrodia cinnamomea is an endemic and medicinal mushroom in Taiwan. So far more than 500 master/PhD thesis and 300 international journal papers studying *A. cinnamomea* were published. Many studies tested bioactivities of *A. cinnamomea* presented positive results indicating that products of *A. cinnamomea* possess higher potential and have international competitiveness in biotechnology. Because *A. cinnamomea* only inhibits on *Cinnamomum kanehirae* which is an endemic tree in Taiwan. It is said that the fruiting bodies of *A. cinnamomea* living on *C. kanehirae* are more effective than those on other host woods. However, there is no evidence to proof this saying. The aims of this study were to produce fruiting bodies of *A. cinnamomea* on different wood substrates and to analyze the different of the eight indication components present in natural fruiting body of the fungus among different wood substrates. The eight indicating components in *A. cinnamomea* included Antcin A, B, C, H, K (that only present in basidiomes of the fungus); and dehydrosulphurenic acid, dehydroburicoic acid and 4, 7-dimethoxy-5-methyl-1, 3-benzodioxole(these three components present in both basidiomes and mycelia of the fungus). The six fruiting bodies of *A. cinnamomea* produced from six woods (*Cinnamomum camphor*, *Ci. kanehirae*, *Ci. micranthora*, *Cryptomeria japonica*, *Cunninghamia lanceolate* and *Cu. lanceolate* var *konishii*) were used for the comparisons. The HPLC chromatograms of the six basidiomes from the six woods were similar and the eight indicating components were all presented in the six basidiomes. The ethanolic extract of the six basidiomes were all more than 24% and the quality order of the six woods were *Ci. camphor*≒*Ci. kanehirae*>*Cu. lanceolate* var konishii > *Ci. micranthora* >*Cu. lanceolate* > *Cry. japonica*. This results indicated that the biosynthetic pathway of triterpenoids in *A. cinnamomea* basidiomes are similar among different growth substrates. If there is any different pathway among different growth substrates needs further studies. In the surveys and cultural preservation of other mushrooms, some potential mushrooms were collected, such as *Ganoderma* spp., *Phellinus* spp. and *Cordyceps* spp.

歸化植物與災害衝擊林地復育之研究

周富三、林朝欽

本研究計畫的主要目的在建立臺灣地區歸化植物可能擴散地理分布之預測模式及建構臺灣低海拔森林生態系演替之不同階段。本計畫完成臺灣全島歸化植物的調查，在4,879個調查樣點中(63,086筆資料)，共記錄420種歸化的維管束植物，分別屬於71科265屬，蕨類植物有1科1屬1種，雙子葉植物有59科218屬348種；單子葉植物有11科46屬72種。這420種歸化的維管束植物大部分都屬於陽性的草本植物，以菊科、豆科、禾本科、旋花科、錦葵科、茄科、大戟科、蓼科、莧科、車前科的植物為主，前10個科的種數高達260種，占所有調查種數的61.76%(260/421)。廣泛分布的歸化的維管束植物有大花咸豐草、野茼蒿、大黍、光果龍葵、孟仁草、飛揚草、紫花藿香薊、小花蔓澤蘭、銀合歡、馬唐，已經將調查的資料建立一個可供查詢的臺灣歸化植物網站，並可提供擴散預測模式使用。完成六龜研究中心多納林道(8.7 K) 1個50m×50m的永久樣區，共記錄到19種樹木，重要值的前5名樹種分別為白匏子(45.61%)、山黃麻(41.2%)、山胡椒(3.58%)、羅氏鹽膚木(2.12%)、賊仔樹(1.95%)，此5種陽性樹木的重要值總和高達94.46%，樹冠層高度為5-7m，顯示此崩塌地仍處於演替早期階段。



8種出現頻度高的歸化植物預測擴散分布圖。
The predicting potential widespread geographical distribution maps of eight most-frequency naturalized plants.

Study on the Naturalized Plants and Restoration of Disaster Damaged Forests

Fu-Shan Chou, Chau-Chin Lin

The purpose of this study was to set up a model that predicts geographical distribution of naturalized plants of Taiwan, and monitor vegetation dynamics on a landslide site of Duona forest road for exploring forest succession. We found 420 naturalized plant species, belonging to 71 families and 265 genera, at 4,879 inventory plots in Taiwan Island. The most abundant species included 54 species of Fabaceae, 53 species of Asteraceae, and 47 species of Poaceae. Among the 420 alien species, *Bidens pilosa* had the highest frequency, appearing in 89.92% of our inventory plots. Results show that there are 19 tree species in the permanent plot (50m×50m), which was dominated by pioneer trees such as *Mallotus paniculatus* (45.61%), *Trema orientalis* (41.2%), *Litsea cubeba* (3.58%), *Rhus javanica* (2.12%) and *Tetradium glabrifolium* (1.95%), especially. Their importance values yielded a total IV of 94.46%. The landslide site is obviously in an early succession stage.

蛀食性林木蟲害之監測、鑑定及防治技術之建立

汪澤宏

林木的蛀食性昆蟲種類繁多，主要以樹木莖幹的纖維素為食。木材分解本為森林新陳代謝的一部分，但在人類居住地周圍或兩地間的交通要道所種植的樹木，如果遭受到蛀食性昆蟲的蛀食而危害到樹木壽命，這些昆蟲即被視為林木蛀食性害蟲。隨著全球氣候變遷、人為樹木種類栽種的變換，林木害蟲相將隨之發生變化。

本計畫已完成等翅目樣本採集及鑑定12種白蟻(臺灣家白蟻、格斯特家白蟻、黃肢散白蟻、截頭堆砂白蟻、黑樹白蟻、赤樹白蟻、臺灣木白蟻、恆春新白蟻、黑翅土白蟻、小象白蟻、新渡戶近歪白蟻、臺華歪白蟻)，完成上述12種白蟻的COII及16S兩基因的序列庫建立，建立3種重要白蟻(臺灣家白蟻、格斯特家白蟻及黑翅土白蟻)的分子快速鑑定技術。完成40種鱗翅目及鞘翅目蛀食性昆蟲COI基因的序列資料庫，可以準確鑑定資料庫中的物種。建立小蠹蟲監測技術及三種造林地(杜英、臺灣欒樹、香桂)小蠹蟲族群監測。完成白蟻化學藥劑(芬普尼)防治的試驗，針對受黑翅土白蟻危害的樹木進行防治，在七個月內黑翅土白蟻不再入侵。完成108種國內林木蛀食性害蟲的資訊及名錄，可供日後參考使用。本研究確認Termatrac™ T3i偵測器，在32公分以內胸徑的樹木可以非破壞性來偵測恆春新白蟻、臺灣家白蟻及黃肢散白蟻三種等至少3種白蟻的蹤跡。

臺灣家白蟻是臺灣樹木重要的蛀食性害蟲。
Coptotermes formosanus is an important tree boring pest in Taiwan.

The Establishment of Techniques of Monitoring, Identification and Control for Wood Boring Pests

Liang-Jong Wang

The species richness of wood boring insects is diverse. They mainly feed on the cellulose from the stems and roots of woods. Wood decomposition should be a part of forest metabolism. The wood boring insects would be considered as pests if they are harmful to trees around human buildings and roads. The fanua of wood boring pests will be altered by global climate change and artificial transformation of planted tree species. The following studies were carried out in the present project. Twelve species of termites were collected and identified in Taiwan (*Coptotermes formosanus*, *Coptotermes gestroi*, *Reticulitermes flaviceps*, *Cryptotermes domesticus*,*Glyptotermes fuscus*, *Glyptotermes satsumensis*, *Incisitermes inamurae*, *Neotermes koshunensis*, *Odontotermes formosanus*, *Nasutitermes parvonasutus*, *Pericapretermes nitobei* and *Sinocapritermes mushae*). DNA database (COII and 16S) of the above 12 species of termites was established. The technique of rapid molecular identification for 3 important termite species (*Coptotermes formosanus*, *Coptotermes gestroi* and *Odontotermes formosanus*) was developed. A DNA database (COI gene) including 40 species of Lepidoptera and Coleoptera was constructed. The monitoring technique of bark beetles was developed. Population monitoring of bark beetles in three tree species of afforestation (*Elaeocarpus sylvestris, Koelreuteria henryi*, *Cinnamomum randiaiense*) had proceeded. Experiment of termite control using Fipronil was conducted. It was focused on trees attacked by *Odontotermes formosanus*, and the populations would not invade chemically treated areas in seven months. We also carried out a compilation of the checklist and ecological information of 108 species of Taiwanese borer pests. The database of those borer pests could be used for pest management in the future. It was confirmed that Termatrac™ T3i could be used to detect at least 3 species of termites (*Neotermes koshunensis*, *Coptotermes formosanus* and *Reticulitermes flaviceps*) in tree trunks of < 32cm diameter nondestructively.

低海拔造林地鳥類在蟲害防治上的潛力研究

葛兆年

鳥類捕食昆蟲是自然食物鏈的一環，故鳥類對森林害蟲產生防治作用。為因應政府推動平地造林，必須提供造林木害蟲管理的配套措施，本計畫調查鳥類對於造林樹種上植食性昆蟲數量的影響。除了持續以步行的方式記錄捕食性鳥類與可能捕食量外，自3月蟲季開始後持續採集與觀察，發現光復大農大富平地森林園區鳥資源豐富，以鱗翅目幼蟲為主要捕食對象。此外，掃網採集的效益高於剪枝條採集，掃網採集到的昆蟲目數及總數皆高於剪枝條採集，並且剪枝條採集的結果似乎較易受到颱風影響，需要較久的時間回復族群量。每樹種各選擇20棵2-4公尺之樣樹，並指定2狀態大小相近之樣樹隨機選定為試驗組(有圍網)及對照組(無圍網)。使用2×2公分之尼龍圍網包圍目標樹種，網目大小可供昆蟲進出但不足以讓鳥類進入，藉以阻擋鳥類取食昆蟲。使用目視的方式調查圍網組與對照組範圍內之昆蟲數量，輔以0.25平方公分之透明網格記錄樹木上的葉片受害面積。

我們選定目標樹種後以圍網的方式阻擋鳥類取食造林木上的昆蟲，並使用掃網調查樹上的昆蟲數量，進一步比較圍網組以及對照組上昆蟲的數量差異，藉以評估(1)低海拔造林木受昆蟲為害程度，(2)鳥類捕食控制有害昆蟲的效益，以及(3)鳥類捕食作為有害昆蟲防治方法的潛力。由7種造林樹種的掃網採集所得資料得知，光臘樹(*Fraxinus formosana*)及臺灣赤楊(*Alnus formosana*)兩樹種之昆蟲族群量(目數、總數)較高，以及楓香(*Liquidambar formosana*)及茄苳(*Bischofia javanica*)的植食性昆蟲較顯而易見，故選擇以上四種樹種進行試驗工作。試驗結果顯示，光臘樹及茄苳上有圍網試驗組及無圍網對照組的葉片受害面積無明顯不同，但光臘樹及茄苳上試驗組記錄到的生物數量顯著高於對照組，光臘樹的結果主要是來自於蜘蛛類群的增加，而茄苳樣區試驗組除了蜘蛛類群的增加外，植食性生物數量(尤其是以啃食方式危害造林木的類群)也顯著高於對照組，顯示鳥類捕食的確可以減少植食性森林害蟲的數量，進而達到森林害蟲防治的功用。楓香試驗組上的昆蟲數量顯著高於對照組，但楓香被啃食的比例極低，且在選定範圍內鮮少發現鱗翅目幼蟲、鞘翅目等以咀嚼式口器啃食葉片的植食性昆蟲，楓香並不適合來評估此區的林木受損程度。臺灣赤楊在短時間內受赤楊金花蟲(*Linaeidea formosana*)啃食嚴重，發生枯萎及大量落葉，可能間接導致有圍網實驗組與無圍網對照組在昆蟲量及葉面受害量上皆無差異。

使用2×2公分尼龍網及PVC水管包圍目標樹木。
The treatment group was enclosed by PVC pipes and nylon net with a mesh size of 2×2cm.

Study on Bird's Potential to Prevent Insect Damages to Plantations at Low Elevations

Chao-Nien Koh

Some birds prey on insects, so they may contribute to the decline of pest populations. In order to provide pest control strategies which cope with a policy of farmland plantation by the government, we evaluated (1) damages of trees at plantation by pests, (2) effects of birds preying on pests, and (3) the potential of birds as tools to prevent trees from damages by insect pests. Among the seven plantation species, insect orders and numbers collected on *Fraxinus formosana* and *Alnus formosana* were more than the other species. Damaging insects on *Liquidambar formosana* or *Bischofia javanica* were more visible than those on other tree species. Therefore, we evaluated the amounts of insects removed by birds in the way of excluding birds from trees of the four species in the following years. The main cause of the difference on *Fraxinus griffithii* was the significantly increased of carnivores (spiders). On the other hand, both the amount of carnivores and herbivore were higher on the *Bischofia javanica* treatment group, suggesting a significant effect of bird preying on pests at plantation. The results showed that there's no significant difference in the amount of insects and the damages of leaf area between treatment and control group on *Alnus formosana*. It has to be mentioned that the treatment trees and control trees of *Alnus formosana* were seriously damaged by *Linaeidea formosana* during the investigation interval. The damaged trees withered and most leaves fell from the trees, so the insect numbers and leaf damaged areas were counted and calculated on very few leaves. The under estimated quantities might affect the results of the comparison between treatment and control groups. The amount of insects on the treatment group was significantly higher than the control group on *Liquidambar formosana*. However, few damaged leaves were observed on *Liquidambar formosana*. Herbivore insects such as larvae of Lepidoptera or Coleoptera which chewed on leaves were hardly found in the *Liquidambar formosana* plantation. *Liquidambar formosana* might not be valuable enough to evaluate the bird's potential on preventing insect's damage to tree leaves.

目視觀察目標樹木上的生物及葉片之受損面積。
Observing the arthropods and leaf damage area on the target tree.

樹木常見病害之研究

傅春旭、張東柱、陳正豐、林介龍

完成2006-2007年間細菌性癌腫病發病地區之調查工作，包含造林地及苗圃皆未發現有遭受感染之苗木及樹木。利用紅蘿蔔切片及培養基完成榕樹、玫瑰、水黃皮、苦楝及臺灣欒樹之細菌性癌腫病菌之分離及接種工作。目前僅榕樹及玫瑰花上分離到之細菌，接種後可在各自分離出之苗木上產生與田間相同的腫瘤。白千層、鳳凰木及部分水黃皮的腫瘤組織之研磨液塗布於紅蘿蔔切片上並未產生任何腫瘤，而培養基中也未分離出可疑之細菌或真菌，初步判斷為非可培養之微生物引發之腫瘤，推測為生理性的腫瘤。以楸樹、臺東漆、苦楝、欖仁、烏心石、桃花心木、臺灣赤楊、臺灣櫸、臺灣欒樹、木賊葉木麻黃、檸檬桉、海桐、白千層、草海桐、茄冬、銀葉樹、水黃皮、青剛櫟及山葵種子為調查及研究對象。進行其種子所帶菌之研究，同時確認所帶菌之病原性。發現一般採收過程中汙染種子的真菌及細菌可透過種子清洗及表面消毒將之排除，常見汙染種子的真菌有*Aspergillus niger*, *Penicillium chrysogenum, Rhizopus* sp.；對於已經感染進入種子表皮的病原菌，無法透過種子清洗及表面消毒的工作將感染於內的病原菌排除。利用系統性的殺菌劑亦無法排除感染在種子內部的病原菌。常見的種媒病原菌有*Pestalotia* sp., *Phyllostica* sp. 及 *Collectotrichum gloeosporioides*。種子消毒的研究顯示，消毒藥劑僅能進行表面處理，對於深層感染種子內的病原菌並無效果。故健康種子的獲得不應僅憑消毒處理，應在採種母樹開花結果前，即進行樹木健康管理工作，以確保健康種子的獲得。

榕樹細菌癌腫病。
Bacterial crown gall on banyan.

Study on the Common Tree Diseases

Chuen-Hsu Fu, Tun-Tschu Chang, Cheng-Fong Chen, Chieh-Lung Lin

We have examined nurseries and afforestation area where crow gall disease had taken place in Taiwan during 2006-2007. There is no infected plant found on those places. *Agrobacterium tumefaceins* were isolated, purified with slices of carrot and PDA plates from banyan, rose, poonga-oil tree, China berry, and flamegold tree. At present, only the bacteria isolated from rose and banyan could produce galls on the seedlings in the field after inoculation. The tissue fluid from pestling gall of paperbark, flamboyant tree and some poonga-oil tree was inoculated on slices of carrot and PDA plates, and there was no gall induced on the carrot slices and no colonies on the PDA plates. It is sure that the bacteria are not the factor to induce gall on these host trees. The galls on the trunk of these trees are not induced by culturable microorganism, and these galls on trunk maybe physiological tumors. Study on the seed-borne pathogens of green maple, giant-leaved Markingnut, China Berry, Indian almond, Formosan michelia, Honduran mahogany, Formosan alder, Taiwan zelkova, flamegold tree, beef wood, lemon scented-gum, Australian laurel, paperbark, sea lettuce, red cedar, looking glass tree, poonga-oil tree ,ring-cupped oak, and wasabi were examined. Fungi were isolated, purified and indentified on those seeds. We made sure the pathogenicity of these fungi, and study the control of important seed-borne diseases. Seeds polluted by fungi and bacteria during collecting could be controlled by washing and surface sterilization. Seeds were often polluted by *Aspergillus niger*, *Penicillium chrysogenum*, *Rhizopus* sp. When interiors of seeds were infected by pathogens, they could neither be controlled by washing, surface sterilization, nor systemic fungicides. *Pestalotia* sp., *Phyllostica* sp., and *Collectotrichum gloeosporioides* were more often found in the seeds. The result of seed disinfection research show disinfection chemical only could do surface sterilization and there was no effect on pathogens in deep-infected seeds. Healthy seeds should not be acquired only by disinfection, and the tree health management should be carried out before seed trees yield blossoms and bear fruit.

農村及周邊生態系生物多樣性效益評估

陳一銘、葛兆年

兩湖山村中三種棲地類型(完整森林；農耕/完整森林；農耕/破碎森林)鳥類群聚顯著不同，其中農耕/破碎森林的鳥類多樣性最高且與另外兩類型樣區差異顯著。即農地的使用對鳥類的影響程度不同，雖然森林棲地破碎化可能帶來負面影響，但整體而言，鄰接農耕地的森林中鳥種組成並沒有明顯變動。北海岸金山兩湖、石門尖山湖、萬里大坪3個大樣區的哺乳動物種類有獼猴、山羌、野豬、水鹿、鼬獾、白鼻心、麝香貓、穿山甲、野兔等，但各區野生動物組成比例差異很大。山羌、獼猴與山豬等3種草食獸有避開山村地景的趨勢，其中山豬達顯著差異；食肉目動物的鼬獾與白鼻心有相反趨勢，其中鼬獾具有顯著性，可見哺乳動物對農業開發有不同的反應。節肢動物分上游(山村)、中、下游(山腳)調查，其中蜻蜓共計錄9科36種，每次調查平均種數以上游9.1種最高，差異顯著。撈網調查共記錄9目37科85種水棲昆蟲，上、中、下游的多樣性沒有差異，但數量則上游顯著多於下游，與農耕用藥程度也有負關聯。此外上游山村保存了鉛色水蛇、唐水蛇、雨傘節、七星鱧、蓋斑鬥魚、大牙蟲等稀有物種，具有保育價值應加重視。以3種鄉土物種進行族群強化，探討就地保育的可行性。建立收穫、保存水車前種子之技術，冰存或乾存一年後發芽率超過95%，人為擴散種子於22處僅6處有幼苗生長，最終有3處開花結實，其族群存續需持續調查。成功繁殖蓋斑鬥魚與七星鱧本地族群，惟釋放後尚未能觀測其存活情形。

傳統山村產業如桂竹林，如今往往成為野生動物之食餌來源。
Villages' conventional products, such as Makino Bamboo shoots, had become wildlife's food sources.

Evaluation on Benefits of Biodiversity to Ecosystems of the Farmland and Its Surroundings

Yi-Ming Chen, Chao-Nien Koh

The bird assemblages among three types of habitat (forest, farm/forest, and farm/forest-patch) were significantly different. The farm/forest-patch type had the significant higher diversity than the other two types. We presume that agricultural activities may influence avifauna with different extent. Overall, bird communities showed no obvious variations in the forest close to farmland. The mammal survey was conducted in three broad areas including Jinshan Lianghu, Shimen Jienshanhu,and Wanli Daping. The survey recorded mammal species including Formosan macaque, muntjac, wild boar, Sambar deer, ferret badger, gem-faced civet, lesser Indian civet, pangolin and wild hare. The ratios of mammal species composition differ greatly between each area. Herbivores including Formosan macaque, muntjac, and wild boar tended to stay away from villages, with a particular significance tendency for wild boar. On the other hand, carnivores such as ferret badger and gem-faced civet had contrary tendency, with a significant tendency for Ferret Badger. The results showed that differnt mammals might have different responses to the agricultural development. Arthropods' survey was done separately in paddies of upper reaches (montane villages), meddle reaches and lower reaches (foothill). We recorded 36 species of dragonflies belonging to nine families. The average number of species detected each plot were significantly higher in upper reaches which was 9.1 in average. The average number of individuals recorded in upper reaches area was also higher with no significant difference. For a netting survey, we had archived aquatic insects of 9 orders, 37 families, and 85 species. There were no significant differences for aquatic insects' diversity among upper, middle, and lower reaches of the terrace. The average number of individuals was significantly higher in upper reaches.It also had a distinct negative relation with the level of applied pesticide. We found some montane villages of the area which preserve rare species including Plumbeous Water Snake, Chinese Rice Paddy Snake, Banded Krait, Asiatic snakehead (*Channa asiatica*), paradise fish(*Macropodus opercularis*), and dark diving beetle(*Hydrophilus acuminatus*).The finding suggests that rural ecosystems may have served as an important role on species conservation. We chose three rare species in order to test in-situ conservation by reinforcing their local populations. We built up a technique of harvesting and preserving the seeds of *Ottelia alismoides*. The germination rate is more than 95% after a year of preservation in low-temperature or dry environment by desiccant. Among 22 seed dispersal sites, seeds at six sites germinated and seeds at three sites eventually flowered and fruited. The following population build-up needs further investigations. *Macropodus opercularis* and *Channa asiatica* bred successfully in the lab, yet the survival rates were difficult to obtain after released.

臺灣重要樹種芬多精成分之探討

Investigation of Volatile Organic Compounds Emission from Important Plantation Tree Species in Taiwan

陳盈如

Ying-Ju Chen

為瞭解樟樹(*Cinnamomum camphora*)葉子釋出BVOCs (biogenic volatile organic compounds)的揮發成分組成及其相對含量動態變化，本試驗採用branch enclosure technique原位現場採樣(*in situ* sampling)的方法監測BVOCs成分，並以ATD-GC-MS (automatic thermal desorption-gas chromatography-mass spectrometry)進行成分分析。試驗結果顯示，夏季與秋季樟樹葉子釋出之BVOCs成分皆以*trans*-β-ocimene (> 96%)含量最豐，其次為linalool (夏季0.25±0.26%；秋季2.91±2.39%)、*allo*-ocimene (夏季0.80±0.15%；秋季0.01±0.01%)以及*cis*-β-ocimene (夏季0.51±0.06%；秋季0.03±0.00%)等萜類化合物；夏季與秋季之BVOCs平均釋出速率分別為69.68±38.59 μg g^{-1} hr^{-1}與7.02±1.95 μg g^{-1} hr^{-1}。一天中最大的釋出速率約於中午11點-12點達到最高，進一步分析得知，樟樹夏季BVOCs之Es及β值分別為2.36±0.47 μg $hr^{-1}g^{-1}$及0.2012$℃^{-1}$，秋季BVOCs之Es及β值分別為2.48±1.94 μg hr^{-1} g^{-1}及0.1901$℃^{-1}$。整體而言，樟樹應屬於中級BVOCs釋出樹種，由本試驗建立的現場採樣方法，除可了解樟樹活體植株釋放的成分組成及各成分在不同時間的動態變化，未來可應用於其他樹種BVOCs釋放潛勢之監測與推估，以做為行道樹、都市綠色造林或不同地區造林樹種選擇之參考。

Seasonal variations of emission rates and compositions from leaf of *Cinnamomum camphora* were measured under controlled conditions using a vegetation enclosure method. Samples were analyzed for BVOC by auto-thermal desorption and gas chromatography coupled to a mass spectrometer (GC/MS). Total emission rates and compositions of terpene compounds in different seasons were compared. It was found that contribution of *trans*-β-ocimene emission rates was predominant among the total terpene emission rates both during summer and fall, the relative content were 97.84±0.47% and 96.70±2.70%, respectively. Significantly higher emissions were found during summer (69.68±38.59 μg $hr^{-1}g^{-1}$) than in fall (7.02±1.95 μg $hr^{-1}g^{-1}$). Standard emission factors that were measured from all sampling data, total normalized terpene emissions from *C. camphora* in summer (2.36±0.47 μg $hr^{-1}g^{-1}$) was similar to that in fall (2.48±1.94 μg $hr^{-1}g^{-1}$), and the β coefficient of total terpene emission rate in summer and in fall were 0.2012$℃^{-1}$ and 0.1901$℃^{-1}$, respectively. The *in situ* sampling established in this study could increase our knowledge on the BVOCs emission in the field and obtain coefficients for the estimation of BVOCs emission.

烏心石舅活性成分Syringin及Caryophyllene之研究

The Active Ingredient Research of Syringin and Caryophyllene from *Magnolia kachirachirai*

洪昆源

Kun-Yuan Hong

木蘭屬(*Magnolia*)最常見的活性成分為厚朴酚(Magnolol)及其同分異構物和厚朴酚(Honokiol)，其在藥用上在國際間有許多實例。葉部位以太麻里樣區MeOH萃取之粗萃物，具有較佳的DPPH自由基清除能力，抑制率為57.20±0.58%，枝條部位以壽卡樣區之MeOH粗萃物，DPPH自由基清除能力較佳，抑制率為42.55±1.35%。烏心石舅精油具有增加細胞存活率，與β-Caryophyllene及Caryophyllene氧化物相比較，皆具有較高的抗發炎反應及細胞存活率，烏心石舅葉部位MeOH萃取之粗萃物及精油對於促炎細胞因子反應，有明顯抑制IL-1β生成之作用，降低促發炎細胞激素的生成。烏心石舅心材部位75%乙醇萃取粗萃物fraction之收率， Syringin 含量最高，枝部位MeOH萃取之粗萃物各分離部之收率，1-14 fraction之收率較高，收率為46.515%，大武山及南仁山精油在薄層層析法方面，皆有Caryophyllene及Caryophyllene oxide成分，南仁山精油含有較高濃度之Caryophyllene成分含量，大武山精油含有較高濃度之Caryophyllene oxide成分含量，15個分離部皆有不錯的細胞存活率及修復發炎反應。氣相層析質譜儀成分分析方面，烏心石舅具有較高的trans-β- Ocimene、(-)-β-Elemene、β-Caryophyllene、α-Bisabolene成分，這些成分皆用於香料工業上，Syringin含量方面，以烏心石舅Taimali 4單株、枝部位分離部Fraction 3含量較高，烏心石舅物種與中國大陸兩物種相比較Syringin含量高於樂東擬單性木蘭及雲南烏心石舅，將精油進行管柱層析研究結果發現，所得到的成分，為Pinene、Limonene、Caryophyllene、Alloaromadendrene、Cadina-1,4-diene等，精油成分分別具有殺細菌，抗發炎等功效。

In genus *Magnolia* the most common active ingredients are magnolol and its isomers honokiol, which have medicinal applications in many international instances. The leaf portion of what? from Taimali site had MeOH crude extracts with better DPPH radical scavenging capacity, inhibition was 57.20±0.58%. For the branch portion, sample from Shouka area had MeOH crude extract with better DPPH radical scavenging ability, the inhibition rate was 42.55±1.35%. Essential oil from *Magnolia kachirachirai* increased cell survival, and conferred higher anti-inflammatory response and cell viability than did both β-caryophyllene and caryophyllene oxide. The leaf parts of MeOH crude extract and essential oil extracts have significant inhibition of IL-1β proinflammatory cytokine response, reducing the generation of proinflammatory cytokines. In antioxidant analysis, yield of 75% ethanol crude extract fraction of *Magnolia kachirachirai* heartwood parts had the highest syringin content; crude extracts of MeOH branch parts extraction had higher yields in 1-14 r fractions, with a yield of 46.515%. Essential oils of Dawu Mountain and Nan-Ren Mountain samples analyzed in thin-layer chromatography found caryophyllene and caryophyllene oxide in compositions. In the Nan-Ren Mountain essential oils contained higher amount of caryophyllene, whereas the Dawu Mountain essential oil contained higher concentration of caryophyllene oxide. All 15 isolates of *Magnolia kachirachirai* parts gave good cell survival rate and ability of repairing inflammation reaction. In *M. kachirachirai* essential oils there were higher trans-β-ocimene, (-) - β-elemene, β-caryophyllene and α-bisabolene content which were all used in the analysis of components in the gas chromatographic mass spectrometer, and these components were used in the fragrance industry. Syringin content in was higher in Taimali sample number four, fraction three. The content of syringin was analyzed by thin layer chromatographic method. The content of syringin was higher than those of the two species of *M. lotungensis* and *M. yunnanensis* in China. Essential oil was subjected to column chromatography study found compositions of pinene, limonene, caryophyllene, alloaromadendrene, cadina-1,4-diene etc., each of the essential oils composition having bactericidal, anti-inflammatory and other effects.

木質纖維材料預處理技術及糖化之研究

何振隆

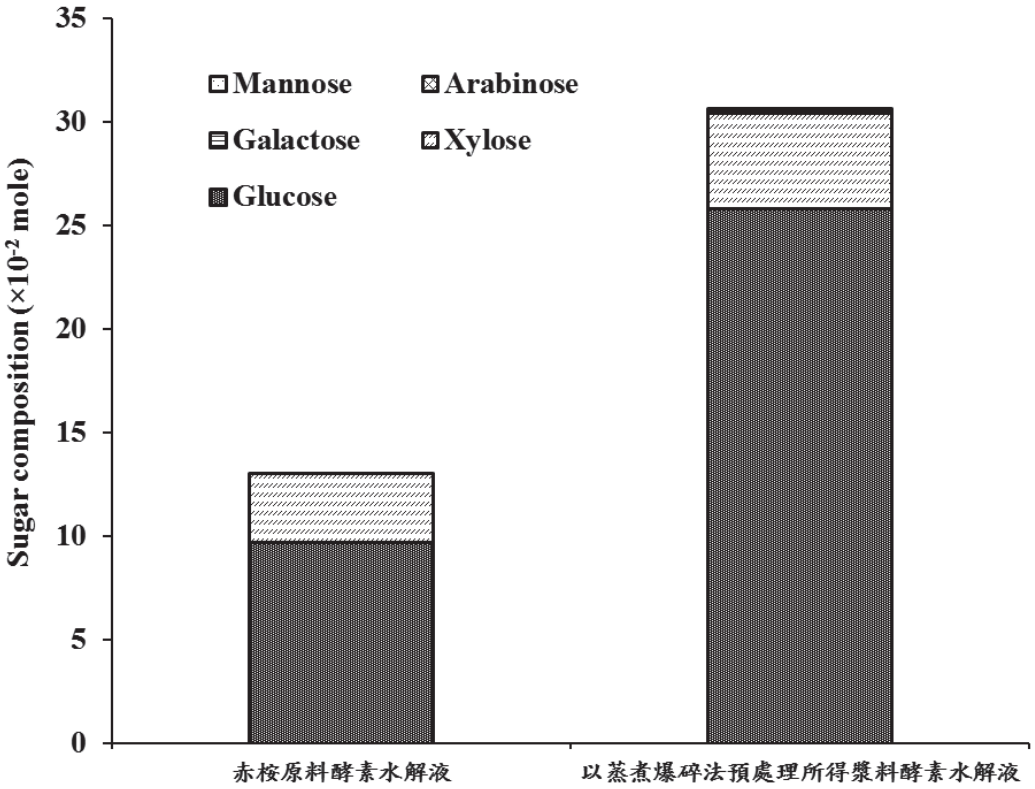
本研究即為評估赤桉(*Eucalyptus camaldulensis*)，以不同條件之蒸煮爆碎處理法予以製漿，評估紙漿化學組成分、紙張物理性質及酵素水解糖化等特性。所得結果，其隨蒸煮爆碎處理強度之增強，收率呈現下降的趨勢；於紙漿化學組成分方面，亦為隨處理強度增強，各成分的含量均呈現降解現象，其中以半纖維素之降解程度為最大，其次為木質素，再其次為纖維素。於紙張物理性質中，當反應溫度為180℃，反應時間為8 min時，其所得之紙張物理強度為最佳，故為理想之蒸煮爆碎處理因子。於酵素水解糖化率方面，經過蒸煮爆碎法預處理所得漿料可促使其酵素水解糖化率明顯提高，從赤桉原料的34.9%的糖化率，經過蒸煮爆碎法後，其漿料糖化率明顯的增加至73.8%，提高了2.11倍。此為因蒸煮爆碎法預處理時，經瞬間高溫高壓處理後，可使木質素及半纖維素產生降解，進而使纖維素酵素的接觸面積提高，故可以明顯增進糖化效率，為一種有效的預處理方法。

蒸煮爆碎設備。
The equitment of steam explosion.

Bioconversion Technologies on the Pretreatment and Saccharification of Lignocellulosic Materials from Forest Biomass

Chen-Lung Ho

In this study, we evaluated treatments of *Eucalyptus camaldulensis* wood chips using various conditions of steam explosion pulping method. The resulting pulp chemical composition, handsheet physical properties, and enzymatic hydrolysis saccharification were evaluated. The results indicated that along with increase in steam explosion strength, pulp yield tended to decrease. As for the pulp compositions, higher explosion strength also caused decreases in various compositions, with loss of hemicelluloses most pronounced, lignin reduction was the second, and cellulose loss was the least. With respect to pulp strength, at reaction temperature of 180℃ and reaction time of 8 min, the pulp had the best properties, hence was deemed as an ideal steam explosion condition. On the aspect of enzymatic hydrolysis saccharification, steam exploded pretreated pulp was inductive to significant enhancement of saccharification, from the original rate of 34.9% for *E. camaldulensis* wood chip to 73.8% saccharification, a 2.11-fold increase. This was thought that in steam explosion, the instantaneous high temperature and pressure caused lignin and hemicelluloses to degrade, leading to increased contact areas of cellulose with the enzyme, hence the significant increase in saccharification rate. We deem it an effective pretreatment method.



赤桉原料與經蒸煮爆碎法預處理所得之漿料，分別經酵素水解液後，所得醣類組成分析比較。

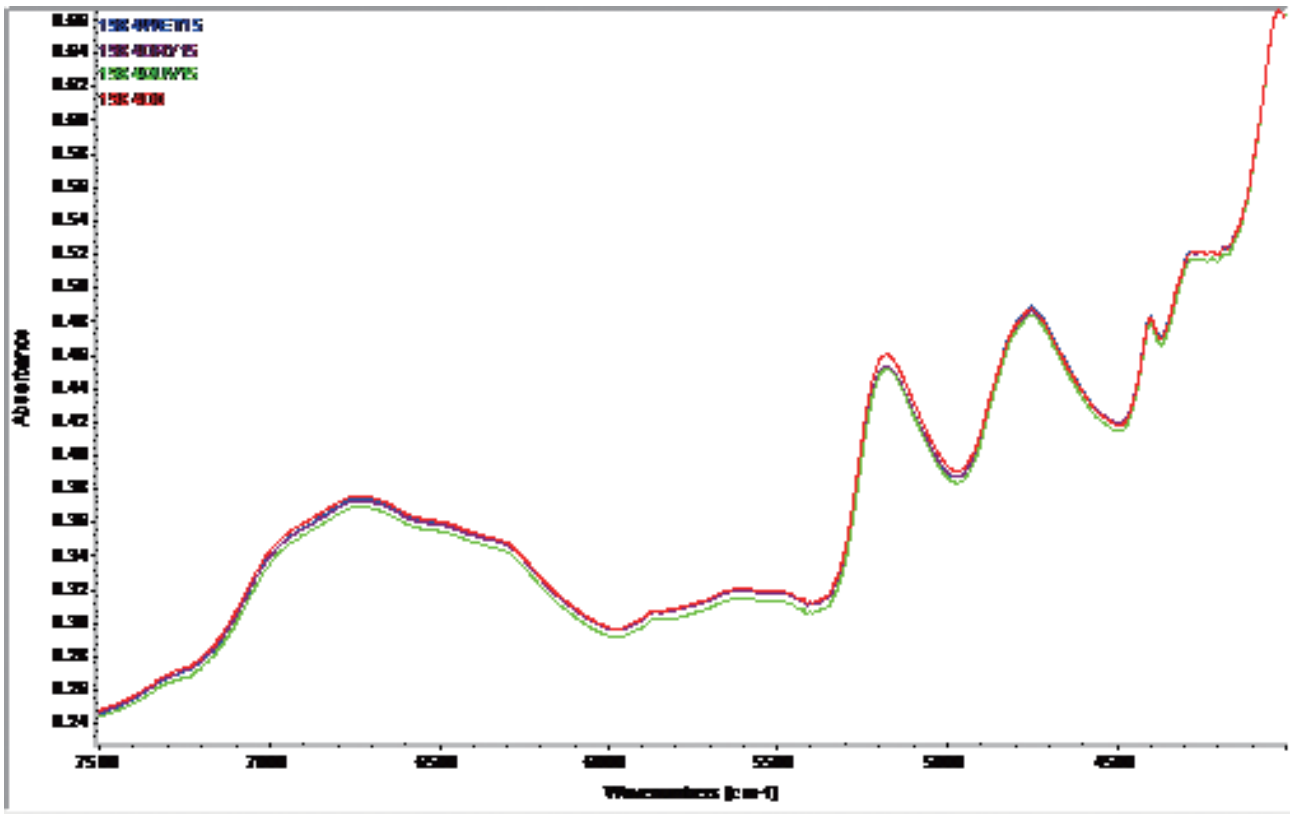
Comparisons of sugar compositions from steam explosion pretreated pulp of E. camuldulensis after enzymatic hydrolysis.

紙質文物加速老化與自然老化相關性之研究

徐健國

由紙張NIR圖譜測試結果發現自然老化越久的紙樣，其吸收度越低，此與傳統評估自然老化方式吻合。雖然許多報告常以耐摺及撕力作為評估紙張老化的指標，但由於在許多細微的差異處物理性質表現不若化學分析靈敏，因此，評估紙張老化的指標時，黏度比耐摺強度或撕裂強度更能貼切的反應紙張老化程度。若是紙張木質素含量低，則白度未必適合作為評估紙張老化的方法。QUV及乾熱老化對紙張破壞較大，其NIR圖譜的吸收度較低，因此若是需要做加速老化，此為評估老化較為理想的加速老化條件。

綜合比較紙張加速老化後物理性質、黏度及NIR圖譜結果，顯示NIR圖譜確實可以呈現紙張老化的趨勢，且由於其操作時幾乎不會損及試材及其測試結果再現性良好，因此NIR不失為另一種非破壞性評估紙張老化趨勢的測試方法。惟目前僅為相對比較老化程度，若要定量評估老化程度，則尚需要有更多的實驗資料方可能進行評估。



以不同老化方式老化紙樣15天之NIR圖譜。
The 15th-day NIR spectroscopies of samples aged with different accelerated aging methods.

Studies on the Correlation between Natural and Accelerated Aging of Paper-based Cultural Relics

Jiann-Gwo Shyu

Based on the near-infrared (NIR) spectroscopy of naturally aged paper specimen, we found that the greater the degree of aging, the less absorbency is shown, which tends to matching traditional methods of assessing paper aging. Although there are often reports using folding endurance and tear resistance as indicators of paper aging, however, there are much nuanced differences due to aging which are not manifested in physical properties as those in chemical analyses. Thus, when evaluating indicators of paper aging, viscosity changes can better showing degree of paper aging than can folding endurance or tear strength do. QUV and dry-heat aging treatments render greater damages to paper sheets, hence their NIR spectroscopy have lower absorbency, the method presents itself as an ideal accelerated aging evaluating tool.

Upon comparing the overall accelerated aged paper specimens with respects to their post-aging physical properties, viscosities, and NIR spectroscopy, the results indicated that NIR can indicate the aging trend very well. In addition, the method does not damage the test specimens and shows good repeatability. Therefore, NIR can be considered to be an effective non-destructive method of evaluating paper aging trend. At present, we use the method to compare relative degree of paper aging, as for quantification of aging degree, further studies are needed.

建築用孟宗竹竹桿之性質評估

塗三賢、黃國雄

本研究以孟宗竹竹稈進行天然乾燥、傳統乾燥與高溫乾燥等三種不同乾燥處理後，進行不同乾燥處理竹材表面之色差試驗，端部吸水試驗與耐腐朽試驗。又以天然乾燥竹材進行強度試驗，包括縱向強度試驗、剪斷強度試驗與抗彎強度試驗，探討竹材表面材色之變化、竹稈之強度性質與竹材之耐腐朽性等，並擬將試驗結果提供給竹材與竹建築相關業者參考，期能提高竹材在建築方面之應用與達到有效利用國內竹材資源之目的。

由試驗結果得知三種不同乾燥處理之竹材得知，其含水率隨乾燥處理溫度提高而下降，即天然乾燥材11.78%、傳統窯乾材8.91%及高溫乾燥材5.72%；亦發現竹材之比重隨竹肉厚度之增加而降低，竹肉厚度收縮率亦隨竹肉厚度之增加而降低，而竹桿直徑收縮率則隨竹桿直徑之增加而增加。此外，竹材的MOR值、MOE值與壓縮強度性質，隨著乾燥處理溫度提高而增大，顯示乾燥處理溫度的提高使得材料剛性有所提升。

傳統乾燥與高溫乾燥竹青與竹黃之色差值均較天然乾燥者大即其顏色加深，且高溫乾燥者之色差值較傳統乾燥者大。於端部塗布環氧樹脂中天然乾燥之含水率與傳統乾燥者相近，而高溫乾燥之含水率則明顯減少。三種不同乾燥之竹材對不同菌種的抵禦能力不同，以高溫乾燥者之抗腐朽能力最佳。天然乾燥竹材之壓縮強度為769±57kgf/cm^2，剪斷強度為186±20kgf/cm^2，MOR為1528±239kgf/cm^2，MOE為10.4×10^4±2.9×10^{4}kgf/cm^2。

三種乾燥處理竹稈抗彎試驗與壓縮強度試驗的結果顯示竹材的MOR值、MOE值與壓縮強度性質，隨著乾燥處理溫度提高而增大，顯示乾燥處理溫度的提高使得材料剛性有所提升。

The MOR, MOE and compression strength increased with increasing treatment temperature, it show that increasing treatment temperature benefited the bamboo culm stiffness.

乾燥類別	密度 (kg/m^3)	含水率 (%)	MOE (GPa)	MOR (MPa)	壓縮強度 (MPa)
天然乾燥	629.08$^{a1)}$ (107.91) $^{2)}$	11.78^c (0.33)	13.00^a (2.46)	80.37^a (16.57)	27.26^a (8.24)
傳統乾燥	726.00^b (66.92)	8.91^b (0.47)	14.09^a (2.81)	90.88^a (16.73)	39.31^b (6.17)
高溫乾燥	719.43^b (62.32)	5.72^a (0.18)	18.31^b (2.41)	92.85^a (19.07)	43.03^b (9.18)

Evaluation of the Properties of Moso Bamboo Culms for Construction Use

San-Hsien Tu, Gwo-Shyong Hwang

In this study, Moso bamboo culms were used as test specimens, we took different diameter specimens to evaluate their specific gravity and shrinkage. Then the bamboo culms were naturally dried (NAD), traditional kiln dried (TKD), or high temperature dried (HTD), and their bending and compression strength determined after drying treatments.

The three kinds of dried bamboos have moisture content that decreased with increasing treatment temperature. The MC of natural dried bamboo was 11.78%, traditional kiln dried one was 8.91% and the high temperature dried one was 5.72%. We also find that specific gravity decreased with increasing culm thickness, and thickness shrinkage decreased with increasing thickness, otherwise, the culm diameter shrinkage increased with increasing culm diameter. Besides, the MOR, MOE and compression strengths increased with increasing treatment temperature, it show that increasing treatment temperature benefited the bamboo culm stiffness.

The result also showed that the colors for the two parts of bamboo, bamboo green and bamboo yellow became darker using TKD and HTD than NAD, particularly, HTD had higher color difference value than TKD. The moisture content on the culm ends, which were coated using expoxy resin, decreased significantly with the HTD than did the treatments of NAD and TKD. On these three drying treatments, HTD had best effects of anti-decay to difference bacteria. The other physical test values of NAD were: compression strength $769 \pm 57 kgf/cm^2$, shear strength $186 \pm 20 kgf/cm^2$, MOR $1528 \pm 239 kgf/cm^2$, and MOE $10.4 \times 10^4 \pm 2.9 \times 10^4 kgf/cm^2$.

公、私有林木竹材產銷平台之建立

林俊成

本計畫(1)調查分析公私有林木竹材資源，並針對竹材消費情形進行調查分析。(2)針對木竹製品製造業之國產木竹材產業需求與消費流向與國內竹材生產與利用之市場調查與產銷進行調查分析。結果顯示：臺灣2003-2012年竹材消費量年平均為1.1萬公噸，生產量占消費量65.8%。1995-2012年間，臺灣地區木材採伐材積以2003年時的總材積伐採量最高為85,542立方公尺，隨後逐年遞減，私有林伐採材積則有遞增的趨勢。以臺灣木竹製品製造業廠商為對象，針對其選擇料源供應考慮因素及對國產材認知及競爭力等進行問卷調查。調查結果顯示，在147份回收有效問卷的廠商中，原木、製材、單板、合板和纖維板以向進口商及代理商採購為主；木炭和粒片板則為自行採購國內原料；木片與粒片以向中間商、零售商採購原料為主。在選擇木材原料供應時，以「供應來源穩定」、「價格合理公道」、「供應數量充分」被認為是重要的因素，可見所需料源的穩定一直為廠商生產所關心；而廠商選擇使用國產材做為原料來源的原因，乃為符合產品(消費者)需求及客製化需求為主；受訪廠商普遍認為國內木材供應來源及數量嚴重不足，是推動使用國產材最大的障礙。因此，為提升國產材使用，「推動木材為綠色產品，納入政府綠色採購優先項目中」、「協助建立國產材產業鏈」、「推動木製產品生產認證」及「開發國產材之多元化利用」為廠商認為可行之策略。

調查竹產業者之生產經營現狀、產業困境的認知。
Survey on manufacturers of bamboo products regarding their current production and management as well as their perceived task difficulty in the industry.

The Establishment of a Production-to-consumption Platform of Communal and Private Wood/Bamboo Resources

Jiunn-Cheng Lin

In this project, the foundation investigation includes an analysis of communal and private forest resources, as well as the current market operation of the bamboo products. The investigation includes analyzing domestic wood and bamboo demands as well as trade flows, and assessing the domestic bamboo framework of the production-to-consumption system via a market survey. The study results show that the average annual bamboo consumption in Taiwan was 11,000tons between the years 2003 and 2012. The total production was only 65.8% of what was consumed. Between the years 1995 and 2012, with regard to the volume of wood harvested in Taiwan, the year 2003 ranked highest with a log volume of 85,542m^3, yet the volume declined by the year while the volume of wood harvested in private forests appeared to increase. A questionnaire was mailed to wood- and bamboo-based product manufacturers in Taiwan to understand what affected their choices of sources of supplies for materials and how much they knew about the domestic timber and its competitiveness. The results from 147 valid respondents showed that the main purchase pathways of logs, lumber, veneer, plywood, and fiberboard were directly through importers and agents, the pathway of charcoal and particle board was self-purchased domestic raw materials, and pathways of chips were mainly by middlemen and retailers. When determining the raw wood material supply, factors of “stability of supply”, “reasonable price” and “sufficient supply quantities” were important concerns. That means a stable material source is a ubiquitous concern of manufacturers. However, the main reasons that manufacturers produce items using domestic timber as material sources were to meet consumers’special needs and customization. Most respondents thought that significant obstacles to promoting domestic timber use were supply sources and a serious shortage of timber. Therefore, to increase the domestic timber use, most manufacturers considered feasible strategies were“promoting timber as green products and taking them to the governmental green procurement priorities”, “building a domestic timber industry chain”, “promoting wood product certification” and “developing diverse uses of the domestic timber”.

林產品消費流向與碳足跡研究

陳溢宏

本計畫針對(1)臺灣主要林產品分析進出口量及進口來源將建置臺灣主要林產品資訊查詢系統，(2)林產品碳足跡產品類別規則文件建立及木竹製板材碳足跡個案調查分析及(3)分析木材進口運輸之碳足跡。研究結果顯示：2003-2014年之實木產品進口價值在新臺幣23,713~37,092百萬元 ，以木質人造板的進口值為最高，占實木產品總進口價值的43%。而實木產品出口價值在新臺幣2,578~4,418百萬元，以木質人造板的出口值為最高，占實木產品總出口價值的51%。由此數字來看，不論在數量或價值，進口皆高於出口，可見實木產品主要滿足國內需求之內需導向市場的趨勢愈來愈明顯。根據所建構木竹製板材之碳足跡產品類別規則文件內容，以個案研究，進行木質地板碳足跡概算，標的產品(1片5KG重之木質地板)之總排放量為5.21266KG-CO_2e。臺灣木材需求量有99%來自進口，而國產材與進口材碳足跡的最大差異，在於原料取得過程經由「運輸」所產生的碳排放。因此以2005~2014年主要實木產品進口貿易資料，估算實木產品於航運之CO_2排放量，研究顯示臺灣進口的實木產品於航運過程的CO_2排放量平均每年為6.7萬公噸(散裝船)及30.9萬公噸(貨櫃船)。每立方公尺實木產品航運所排放的CO_2為3.18~47.69kg/m^3(散裝船)、14.52~212.22kg/m^3(貨櫃船)。每立方公尺實木產品航運的CO_2排放量佔CO_2固定量的比例為0.26~3.82%(散裝船)、1.19~17.43%。本研究計算實木產品於航運過程產生的碳排放，研究成果可做為產品碳足跡之估算，以及未來國產材推動地產地銷減碳效益之估算依據。

臺灣主要林產品貿易統計網站。
Website on trade statistics of major forest products in Taiwan.

Consumption Flow and Carbon Footprint in Wood Products

Yi-hong Chen

This research includes collecting and organizing the data of the following three studies: (1) analyzing import/export quantity and sources of import of main processed forest products to establish an information inquiry system; (2) compiling the commodity classification documents of the carbon footprint of wood products along with case analyses of the carbon footprint of wood and bamboo sheets, and a comparative analysis of the changes in wood and bamboo products imports; (3) analyzing the carbon footprint of wood import and trade statistics of major forest products in Taiwan.

There are three results. First, the import value of solid wood products of 2003-2014 was NT$ 23,713-37,092$\times 10^6$ per annum, among which wood composite panels ranked the highest, making up 43% of the total import value. On the other hand, the export value of solid wood products was NT$ 2,578-4,418$\times 10^6$, among which wood composite panels topped the list, making up 51% of the total export value. As is seen from the figures, imports were higher than exports in both quantities and value. Therefore, a domestic market-oriented trend in the demands for solid wood products will be gaining more significance. Second, According to CF-PCR (Carbon Footprint- Product Category Rules), the case studies of wood and bamboo sheets estimated the carbon footprint of wooden flooring, the total emissions of which were 5.21266 KG-CO_2e. Third, as Taiwan relies heavily on wood imports as much as 99%, between domestic timber and imported timber, the most significant difference in the carbon footprint lies in the carbon emissions resulted by the transportation of obtaining raw materials. Hence, basing on the data of major solid wood products import of 2005~2014, this study estimated the CO_2 emissions from the transportation. The results indicated that the average CO_2 emitted annually from the transportation of Taiwan's imported solid wood products was 67,000 tonnes from bulk carriers and 309,000 tonnes from container ships, respectively. The amounts of CO_2 emitted during the transportation for every cubic meter of solid wood products are decided mainly by the shipping distance and types of carriers. Transporting every cubic meter of solid wood products resulted in 3.18kg/m^3 to 47.69kg/m^3 CO_2 emissions by bulk carriers and 14.52kg/m^3 to 212.22kg/m^3 emissions by container ships. As this paper estimates the carbon emissions produced during the transportation of solid wood products, its results can contribute to the estimations of the carbon footprint of products. This study also lays the groundwork on which the efficacy of minimizing CO_2 emission levels is

林產經濟振興策略規劃計畫

邱祈榮

鑒於國際綠色經濟意識之發展，以及國內林產業沉寂已久亟需振興，林試所受農委會委託於民國105年間執行林產經濟振興策略規劃計畫，針對全國公、私有林現有林產業資源進行盤點，調查當前林產業於「資源、生產、製造、供銷、市場」等五大面向之現況與困境，兼之比較國外經驗綜合分析並引入我國林產業可採納之優良方案，進一步提出國內林產業振興突破現況之可行性策略提案。

經實查與了解全國公、私有林現有林產業資源，將國內具經濟利用價值之林業資源規劃為不同區位之生產性人工林。研究團隊以地理區為劃分依據，劃設六大林木、四大竹林資源生產潛力區，作為未來林業生產區位。在具經濟利用價值之生產性公、私有人工林之範疇中，林木資源約3.2萬公頃，木竹混合林資源約4萬公頃，竹林則約6.5萬公頃，生產性人工林資源共計13萬7千餘公頃。

產業部分根據經濟部工業局、商業司以及相關同業公會登記之木竹產業業者進行訪查，親訪132家加工製材廠，並以問卷方式調查另1,400餘家廠商，廣收產業之營運現況與經營困境，並提出具體策略。包含有效結合產、官、學三大面向規劃深具發展潛力之宜蘭、新 竹、臺中、嘉義與高屏等五大產業聚落，透過擴大經營 規模、掌握供需量能、降低生產成本、結合研究資源並 加強基礎管理等方式，持續振興國內傳統林業之發展。

本計畫亦提出創新林產與精緻林業之「單木經濟」模式，即消費者可從林地選擇特定的一株林木，再結合「一條龍」式生產服務，精緻伐採、設計、製造，整合生產面向的各個環節並提高獲利區間。同時，也提出打破傳統以生產者為導向之市場模式，改以提供客製化消費體驗之創新林產業消費者導向策略，以積極推展「精緻私有林業」之高產值經營導向為目標，進一步達成高產值、高品質之國產林業與健康之產業發展。

林產經濟振興策略規劃座談會。
A forum on economic revitalization of forest products industry

Strategic Planning on Economic Revitalization of Forest Products Industry

Chyi-Rong Chiou

In light of the development of international green economy awareness, and to revive the long-standing domestic forest industry, the Council of Agriculture (COA) has entrusted Taiwan Forestry Research Institute (TFRI) to execute The Plan for Economic Development of Forest Products of 2016, to make inventory on the existing national public and private forest industry resources, and to investigate the 5 aspects of situation and dilemma that current forest industry is facing; resources, production, manufacturing, supply and marketing, market. Compare and analyze experiences from other countries, adopt the plan that best fit our forest industry, and propose strategic plan that could make a breakthrough to revive domestic forest industry.

After checking and understanding the existing national public and private forest industry resources, the domestic forest industry resources with economic value will be planned for different locations of productive forest plantations. The research team has designated 6 wood forest resources production potential areas, and 4 bamboo forest resources production potential areas based on the geographical areas, as the future forestry production locations. As for the range of public and private productive forest plantations with economic values, forests with wood resources are about 32,000 hectares, forests with both wood and bamboo resources are about 40,000 hectares, and forests with bamboo resources are about 65,000 hectares, the total of productive forest plantations with resources are about 137,000 hectares.

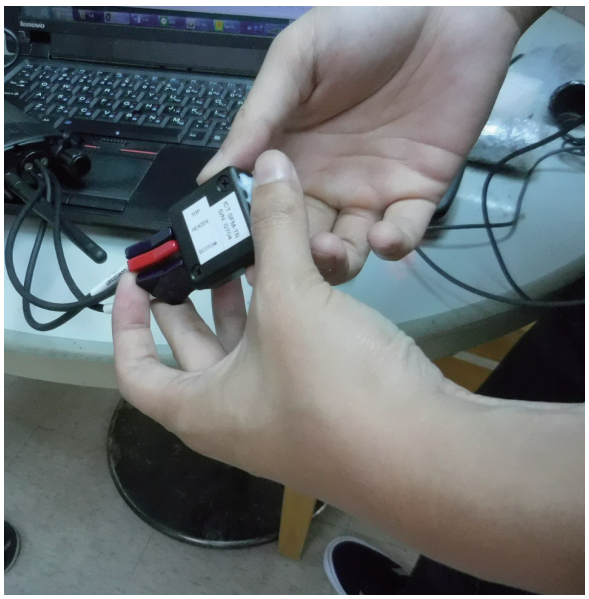
As for the industry part, the research team will conduct inter-view with the Industrial Development Bureau and Department of Commerce of the Ministry of Economic Affairs, and owners of wood and bamboo industry which has registered to related industrial guilds, visit 132 processing factories, and do research on 1,400 or more manufacturers using questionnaire, to under- stand the current operational status and difficulties in the indus- try, and to provide specific strategy. Continuously revitalize the development of traditional domestic forest industry by combin- ing the industry with government and school academia in places with developing potentials, such as Yilan, Hsinchu, Taichung, Jiayi, Kaohsiung and Pingtung, and through expansion, un- derstanding the supply and demand, reducing production cost, combining research resources and reinforce basic management

This research also proposes “Single Wood Economy” model for innovative forest and refined forestry, which means consumers can choose specific wood from the forest, and combine with “train service” styled production, fine-cutting, designing, manufacturing, an integration of production-oriented aspects and improve profit margins. Meanwhile, this research also proposes to adopt innovative consumer-oriented strategy, to provide customized consumer experience, instead of the traditional producer-oriented market model, with goals to promote high-value management of “exquisite private forestry,” to further achieve high-yield, high-quality and healthy domestic forestry industry development.

樹醫技術開發與應用

吳孟玲、劉則言

為提供正確的樹木保護知識與服務，讓管理者能對樹木能進行妥善的維護管理，使其發揮最大的生態服務效益與價值，並針對樹木本身特性進行分析，完善樹木資源運用與促進相關產業發展，林業試驗所已於2012年設立國內第一個官方「樹木醫學中心」，希望能藉此落實我國樹木健康管理及生態環境維護，並使樹木資源得以有效運用。現今國內雖不乏樹木保護相關專業人員及技術，但對於樹木醫學之相關研究，仍急需整合各方面技術及資源，以提供專業樹木健康診斷、樹木資源開發應用及相關專業人才培訓養成。本計畫透過購置螢光倒立式高階光學顯微鏡、樹液流動監測儀、應變測定儀、CTC自動進樣系統、木屑粉塵吸塵器及管線佈置、中型桌上型濃縮機共六樣先進的樹木健檢及樹木資源分析之儀器設備，建立國內樹木檢測及分析技術標準作業流程，讓我們透過精密儀器來即時監測樹木生理生化反應，並以此協助樹木保護人員研判該樹的健康狀況，以作為該樹木未來維護工作之參考。各儀器之導入與標準作業流程的建立，均能提供樹木相關研究者不同面向的樹木資訊，將有效強化樹木健康管理策略的發展並提升作業效率，有助維護樹木之健康、資源應用與產業開發，提升國家經濟。



本計畫建立樹液流動監測技術。
The technique of sap flow sensor is developed in this project.

The Development and Application of Tree Medical Techniques

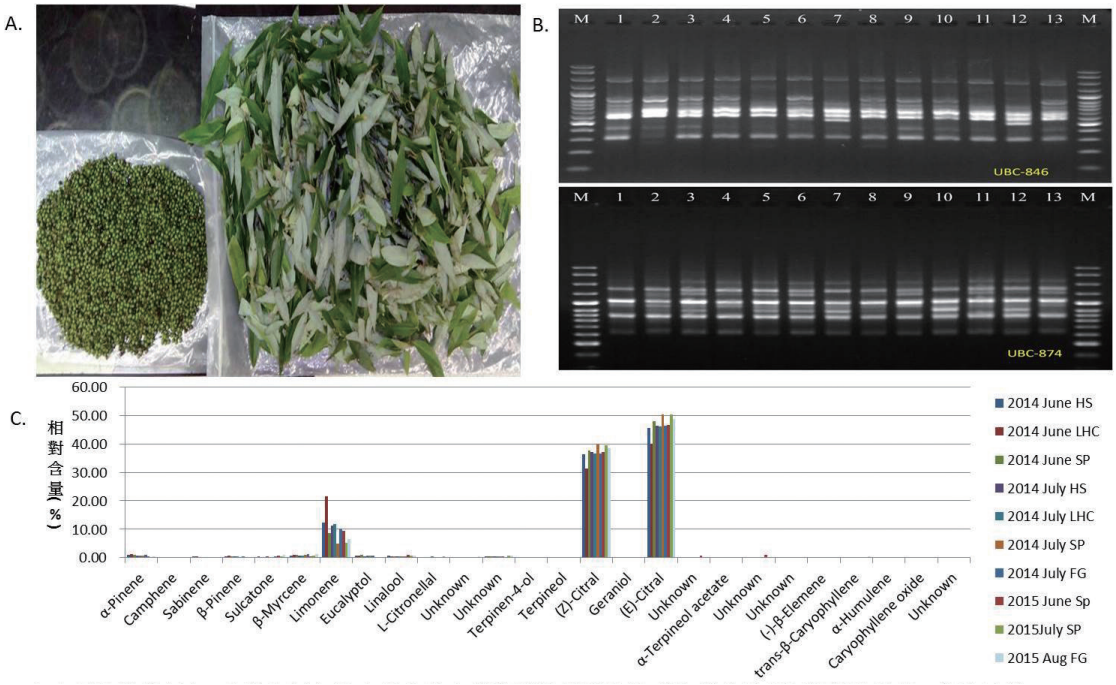
Meng-ling Wu, Tse-Yen Liu

Taiwan Forestry Research Institute (TFRI) has organized an unprecedented official "Arboricultural Medicine Center(AMC)" in 2012 so as to correctly execute the tree management and ecological environment protection as well as to efficiently utilize tree resources. The center provides a series of information and knowledge of the tree protection and services; which allow tree managers to accordingly manage trees in their maximum of ecosystem services and values, analyze trees based on their features, utilize tree resources and promote related industrial developments. Although there are many tree protection professionals and technologies, there is a lack of holistic studies on the integration of technologies and resources to allow professional tree health diagnoses, tree resource development and application as well as personnel training. In this project, we plan to purchase and utilize inverted fluorescence microscope, sap flow sensor, strain transducer and sensor, CTC automatic servo system, vacuum cleaner and pipe arrangement for sawdust and dust, and medium-sized table top concentrator. Our research team will establish the standard procedures of inspection and analysis techniques, which aim to monitor the physical and chemical reaction, and assist in judging tree's health conditions. The application of the devices and establishment of the processes will provide various aspects of tree information, enhance health control, offer strategies of resource development and increase operation efficiency. Furthermore, it will contribute to maintaining urban tree health, promote resource application, develop industry, and heave country's vitality.

山胡椒種原蒐集、精油品系遺傳分型與分子鑑定

陳怡蒨

山胡椒(*Litsea cubeba* L.Persoon)為樟科木薑子屬常綠灌木或小喬木，全株包含果實及樹葉皆具有特殊的芳香氣味，長久以來為原住民傳統調味食品。除了用於調味外，山胡椒自古以來為民間傳統用藥，具有優良的醫藥用價值，而山胡椒果實精油具有獨特芳香，因此大量使用於香水與化妝品產業。山胡椒可謂全身是寶，是用途十分廣泛的多功能植物，具有經濟開發價值。為瞭解臺灣不同地區山胡椒果實及葉片精油含油率以及其精油主要成分間的差異，本研究針對不同地區的山胡椒分別進行果實與葉片樣本採集。樣本以水蒸餾法進行精油萃取，並分別計算其精油收率。利用GC-MS分析精油主要成分，以了解不同地區的山胡椒其精油成分是否具有歧異性。除了分析精油成分之外，本研究也利用ISSR分子標誌技術進行分析，以了解不同地區山胡椒族群間的遺傳歧異度。由分析結果來看，不同地區的山胡椒果實及葉片，其精油收率有明顯差異。在葉片精油收率部分，不同地區的山胡椒葉片精油收率由0.17~3.99%不等。在果實精油部分，不同地區的山胡椒果實精油收率也有明顯的差異(3.48~7.57%)。果實精油成分分析結果顯示不同地區的山胡椒果實精油其主要成分都是檸檬醛(Citral)(香葉醛Geranial和橙花醛Neral的總和)(56.64~83.93%)和檸檬烯(Limonene) (4.11~17.08%)。二者的總和佔果實精油總成分的73.73~88.71%。在葉片精油成分部份，分析結果顯示，不同地區的山胡椒葉片精油其主要成分都是桉油醇(Eucalyptol) (44.25~58.32%)和檜烯(Sabinene) (11.67~14.72%)。此二個主要成分的總和佔葉片精油總成分的56.96~73.04%。本研究分析結果顯示臺灣原生的山胡椒具有開發潛力。這些研究成果可做為後續進行山胡椒優良品系選育以及推廣利用的參考。



A.山胡椒果實(左)以及葉片(右)。B.山胡椒樣本利用ISSR UBC-846, 874引子進行PCR擴增所得之電泳圖譜。C.不同來源山胡椒果實精油GC-MS分析結果。

A. Fruits (left) and leaves (right) of *Litsea cubeba*. B. ISSR profiles of *Litsea cubeba* samples amplified using UBC-846 and UBC-874 primers. C. Compounds of *Litsea cubeba* fruit essential oils identified by GC-MS analysis.

Germplasm Collection, Molecular Genotyping and Identification of Essential Oil Composition of *Litsea cubeba* (Lour.) Persoon

Yi-Chiann Chen

Litsea cubeba Pers. (LC) is a deciduous bush or small tree mostly distributed in the East Asia region. It is a precious aromatic plant with multiple functions. In this study, leaves and fruits of LC were collected from different regions of Taiwan. Essential oils (EOs) of collected sample were obtained by hydro-distillation method and the oil yield was calculated. The compounds of EOs were identified by gas chromatography-mass spectrometry (GC-MS) to assess the differences in EO compositions of LC collected from different parts of Taiwan. In addition to analyzing the essential oil components, ISSR DNA marker were used to estimate the genetic diversity among populations of LC. The results of analysis indicated the yields of EOs in both fruits and leaves were significantly different between regions. Yield of LC leaf EOs from different regions ranged from 0.17 to 3.99%, meanwhile, yield of LC fruit EOs ranged from 3.48 to 7.57%. Although EOs yields and relative content of EOs chemical components varied on origins of LC leaves and fruits, the dominant components of LC leaf and fruit EOs from different areas were the same. LC fruit EOs were mainly represented by citral (sum of geranial and neral, 56.64~83.93%) and Limonene (4.11~17.08%).The sum of the two main components (citral and limonene) accounted for 73.73~88.71% of the total EO of LC fruits. The dominant components of LC leaf EOs were eucalyptol (44.25~58.32%) and sabinene (11.67~14.72%). The sum of the two main components (eucalyptol and sabinene) accounted for 73.73~88.71% of the total EO of LC leaves. The results of this study indicated the potential of Taiwan's native LC for further industrial development. These investigations would provide information for future breeding programs and industrial application of LC.

林木品種性狀檢定開發及新品種研發

Establishment of Test Guidelines for Tree Varieties and New Variety Research and Development

何政坤

Cheng-Kuen Ho

林木品種權是林產業發展根基，目前除紅豆杉具有性狀檢定表而被主管機關公告為林業第一個公告品種外，尚有許多有潛力經濟樹種有待申請品種權保護。土肉桂肉桂醛型與伽羅木醇型具有商品化價值，肉桂醛型土肉桂雖然已經商品化，但選育零檢出香豆素品種是飲料業與動物飼料重要的原料來源。伽羅木醇型土肉桂含有高純度S型伽羅木醇精油，在全世界具有獨特性，且具有高機能性的功能。開發土肉桂成為公告作物品種的性狀檢定表，有利於此二品種保護。完成土肉桂性狀檢定表，向主管機關農糧署提出建議公告，2016年11月2日林務局召開土肉桂為適用植物品種及種苗法之物種，審查修正通過。南洋紅豆杉臺紅3號，在6月份行文給主管機關農糧署申請南洋紅豆杉臺紅3號品種權，本案亦在同時與土肉桂審查同期，審查結果為修正通過。具有抗簇葉病的雜交泡桐經過田間檢定，具有耐熱抗病且速生的特性，為使泡桐能在溫室內檢定，開發以花穗嫁接，觀察花朵、果實與苗木新葉側脈數性狀頗適合作為性狀檢定的調查方法。

Tree variety is the developmental foundation of forest industry. At present, only *Taxus* species was announced to be a tree species with guidelines to apply for new variety by authority (Council of Agriculture). There are many potential valuable tree species to be applied for plant variety. *Cinnamomum osmophloeum* ct. cinnamon and linalool are two chemical races have valuable used in commercial market. There are many commercial products made from cinnamon races, however, beverage and animal feed industries want the races without coumarin. Linalool race contains unique pure S form linalool with biological activity function in the world. The guidelines for *C. osmophloeum* was applied to announce an official plant variety right in June and was accepted on 2 Nov. with minor revision. *Taxus sumatrana* 'Taiyew no.3' was applied to be a new variety in June; it was accepted with minor revision on 2 Nov. Witches' broom resistant *Paulownia* hybrids has been confirmed in field test. It is very important to establish the guidelines for *Paulownia* varieties. To test varieties of *Paulownia* trees in greenhouse, the flower spikes were grafted onto seedlings to observe the morphological characters of flowers, fruits, seeds, and leave veins of seedlings by using man-made pollination. We found some characters could be identified among hybrids and become the major items of guidelines.

土肉桂不同化學品系之葉片性狀差異性檢定。

Identification from differences of leaf characters among chemical races of *Cinnamomum osmophloeum*.

樹木移植標準作業技術研發

The Study on Technology of Standard Trees Transplanting

鄧書麟

Shu-Lin Deng

隨著國民經濟的快速發展，人們生活水準不斷提升，重視環境綠美化的程度也與日俱增，包括都市中的街道綠化、公園遊憩區的景觀規劃及校園綠美化的栽植作業等都備受矚目。為提高都市綠化及景觀造園中喬木類成樹移植的成活率並兼及景觀效果與避免強度修剪所造成的樹型破壞，運用本中心苗圃中之成樹苗針對不同樹種之移植季節、斷根技術及修剪規範進行探討，以供相關作業之參考。

本研究進行福木、蘭嶼羅漢松、烏心石與光臘樹等樹種之成樹移植作業探討。依據福木與蘭嶼羅漢松於春、秋兩季進行移植後8個月之生長表現發現，福木並不適於在秋季進行直接移植作業(存活率33.3%)，但如透過斷根作業則兩樹種於春秋兩季均能進行移植。至於烏心石與光臘樹於春季移植後8個月之生長表現發現，烏心石並不適於春季進行直接移植作業(存活率僅28.6%)，但如透過斷根處理後兩個樹種均可達100%存活率。

根球深度與各樹種根系分布有關，因此可藉由根系分析後再調整根球深度。另由根系分析結果顯示，以上四個樹種如採未斷根直接移植時，樣木根系中的細根數量均遠低於採一次及二次斷根處理樣木之細根數量。另就以上樹種在不同季節移植時其細根數量變化發現，透過斷根處理確實能有效提高土球上層約0-50cm處細根之數量。

With rapid development of national economy, people's standard of living is gradually uplifted, and level of appreciating environmental greening is promoted as well. For example, city street greening, landscape planting in recreational areas, and planting in schools are all highlighted. Hence, to raise both the survival rate of big trees and landscape effect, and to avoid the destruction of tree form, the tree seedlings in our nursery were used to investigate the following issues: transplanting seasons of various tree species, the technology of root pruning, and the norm of trimming. The results in our study could provide reference to other related projects.

The study investigates the adults tree transplanting procedure for *Garcinia subelliptica*, *Podocarpus costalis*, *Michelia compressa* and *Fraxinus formosana*. The growth situation of *Garcinia subelliptica* and *Podocarpus costalis* is individually observed after eight months when their transplanting has been done during the spring and fall seasons. We found that only *Garcinia subelliptica* is not fit to transplant without root pruning (the survival rate is 33.3%), but these two tree species are both fit to transplant during the spring and fall seasons if root pruning is employed. As for the growth situation of *Michelia compressa* and *Fraxinus formosana* after eight months of transplanting in spring, we found that only *Michelia compressa* is not fit to transplant without root pruning in spring (the survival rate is 28.6%), but these two species are both fit to transplant and reach a 100% survival rate if root pruning is employed.

The ball depth relates to the root distribution of tree species. Hence, the ball depth can be adjusted through root analysis. Finally, through root analysis, the results show that for these tree species without root pruning, the amount of the fine roots is far lower than that through the procedures of one-time or two-time root pruning. In addition, by examining the variation in fine root amounts of the above tree species when transplanting was done during different seasons, the root pruning procedure was found to certainly and effectively increase the amount of the fine roots which take place at about 0-50cm on the upper layer of the root ball.

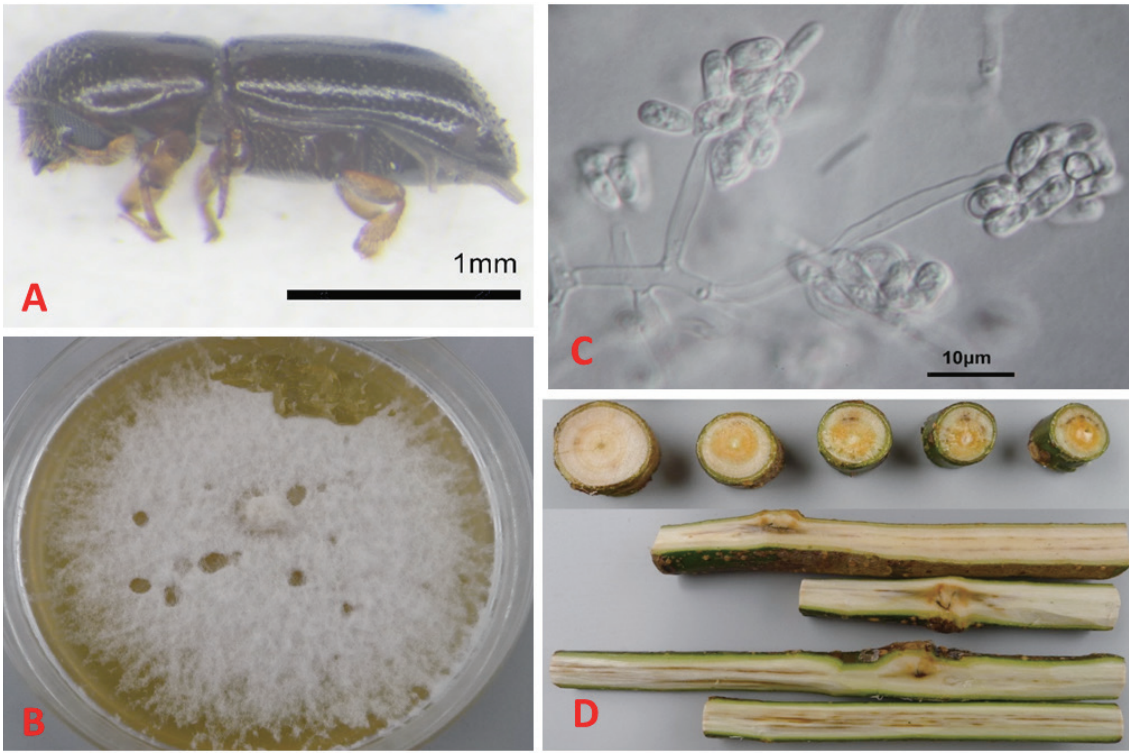
進行福木、蘭嶼羅漢松、烏心石與光臘樹等樹種之成樹移植作業情形。

The adult transplanting procedure for *Garcinia subelliptica*, *Podocarpus costalis*, *Michelia compressa* and *Fraxinus formosana*.

臺灣地區林木長喙殼菌之研究及防治

施欣慧、林俞廷、陳啟予、林清山、陸聲山

長喙殼菌為森林中廣泛存在的真菌種類，藉由小(菌)蠹蟲傳播，感染健康樹木、衰弱木或風折木，部份種類甚至可造成維管束萎凋、藍染或林木根莖部之危害，造成樹木死亡或降低木材品質。其中，長喙殼菌中的*Ambrosiella*屬和*Raffaelea*屬屬於菌蠹菌，由菌蠹蟲攜帶傳播，近幾年於美國地區發生嚴重之樟科植物萎凋病(病原菌為*Raffaelea lauricola*)，即屬於此類型病害。本計畫於高雄六龜、南投蓮華池、臺北信賢苗圃和宜蘭福山等地設置誘引器，定期捕捉森林中的小蠹蟲，並監測樟科植物萎凋病之媒介菌蠹蟲*Xyleborus glabratus*的族群。結果顯示，迄今只於信賢苗圃及福山等樣區，才可捕捉到菌蠹蟲*X. glabratus*，且數量稀少(平均每月捕捉數量介於0~10隻)。接著，由*X. glabratus*儲菌器中可分離到3種*Raffaelea* spp.，其中，包含病原菌*R. lauricola*。將分離之病原菌*R. lauricola*接種在4種臺灣原生之樟科植物，包括樟樹、土肉桂、香楠和紅楠等，經過8個月後，受接種的苗木的邊材上只出現局部輕微的黑染情形，並未出現萎凋病徵，顯示此4種臺灣原生之樟科植物對此病原菌具有較高的抗性。此外，分離具中胸型儲菌器之菌蠹蟲之共生真菌，再透過真菌形態及DNA序列分析，共鑑定出5種共生之長喙殼菌，分別為*Ambrosiella nakashimae*、*A. beaveri*、*A. roeperi*、*A. grosmanniae*和*A. catenulata*，其中，*A. catenulata*為本研究發現的新種。



A：美國樟科植物萎凋病之媒介菌蠹蟲*Xyleborus glabratus*。B：樟科植物萎凋病病原菌*Raffaelea lauricola*在MEA培養基上的菌落型態。C：病原菌*R. lauricola*的真菌形態。D：病原菌*R. lauricola*接種香楠苗木後，邊材產生黑染變色之病徵。。

A: The vector of the American laurel wilt disease, *Xyleborus glabratus*. B: The colony of *Raffaelea lauricola*, which is the pathogen of the laurel wilt disease, on malt extract agar medium (MEA medium). C: The fungal morphology of *R. lauricola*. D: The sapwood of *Machilus zuihoensis* developed a light pale gray discoloration following inoculation of *R. lauricola*.

The Study and Management of Ophiostomatoid Fungi in Taiwan

Hsin-Hui Shih, Yu-Ting Lin, Chi-Yu Chen, Ching-Shan Lin, Sheng-Shan Lu

Ophiostomatoid fungi are omnipresent in the forest and they could be carried to dispersal by ambrosia or bark beetles. Some species of ophiostomatoid fungi could cause vascular wilt, blue stain or diseases of stems or roots in the forest. Besides, they also lower the use quality of wood. Among the ophiostomatoid fungi, the genus, *Ambrosiella* and *Raffaelea*, belong to the ambrosia fungi and are carried by ambrosia beetles. The pathogen, *Raffaelea lauricola*, of laurel wilt, that outbreak seriously in USA also belonged to the ophiostomatoid fungi. In the project, we set traps in Liouguei (Kaohsiung), Lienhuachih (Nantou), Xinxian (Taipei) and Fushan (Ilan) to trap Scolytinae beetles in the forest and monitor for the population of *Xyleborus glabratus*, the vector of American laurel wilt. The result showed that *X. glabratus* was only trapped in Xinxian and Fushan and the trapped numbers of *X. glabratus* were few (0~10per month). Then, we isolated 3 *Raffaelea* species from the mycangia of *X. glabratus* and one of them was *R. lauricola*. The isolated *R. lauriocla* was used as inoculum, and four laurel species, *Cinnamomum camphora*, *C. osmophloeum*, *Machilus zuihoensis*, *M. thunbergii* native to Taiwan were inoculated. After 8 months, these inoculated seedlings developed only a light pale gray discoloration in the sapwood, but no wilt symptom was observed. The results showed that the four laurel species are more resistant to laurel wilt. On the other hand, we also isolated symbiotic fungi from the ambrosia beetles with mesothoracic mycangium and identified them based on fungal morphology and the DNA sequence analysis. Five *Ambrosiella* species including *Ambrosiella nakashimae*, *A. beaveri*, *A. roeperi*, *A. grosmanniae* and *A. catenulata* were identified, among them *A. catenulata* was a new species found in the study.

林木疫情監測及防治體系及重大病蟲害網路綜合管理研究

Research on Forest Epidemic Diseases Monitoring and Prevention System

吳孟玲、莊鈴木

Meng-Ling Wu, Ling-Mu Jaung

105年本計畫持續更新、維護、管理及開發農委會「林木疫情監測及防治體系」各網站系統。依體系分工架構協助林務局維護「林木疫情管制、策劃與防治中心」網站，擴充管理系統功能，以及強化林業試驗所「林木疫情鑑定與資訊中心」之網站功能，包括開放地圖範圍查詢功能、新增各縣市案件查詢及危害種類查詢等功能，並每日定時備份虛擬主機系統及網站資料庫，增加網站運作穩定及安全性，使二網站中心形成網狀聯繫，統合行政資源，協助落實國內林木疫情管制之效能。本計畫亦將「林木疫情鑑定與資訊中心」、「樹木褐根病調查通報系統」及「筆筒樹疫情監測網資訊網」三網站彙整於統一資料庫，提升資料整合查詢、分析之效能，並將褐根病檢疫及林木非破壞性檢測等服務新增至「林木疫情鑑定與資訊中心」服務項目內，105年1月1日累計至105年12月31日，受理林木疫情之通報案件共計1,646件。整合「樹木醫學中心」與「林木疫情監測及防治體系」網絡，及其服務業務，開發樹木醫學中心相關網絡服務系統，並辦理樹醫座談會及研討會共計6場，講習班共計12場，以利防疫工作之推展。

This project purposes to maintain and update the web systems of “Forest Epidemic Diseases Monitoring and Prevention System”. According to the work division, the Forest Bureau on will be continuously supported to maintain “Forest disease & pests control, planning and prevention center”, extend and upgrade the services of “Diagnosis and information center of forest diseases and pests”. Extra functions will be added including search inquires with maps, searching individual cases by counties, checking affected tree categories, and a virtual host to back up all web data and increase the safety of the web The integration of different resources is also addressed in this project. An integrative service will make the forest monitoring system a connected hub and raise the efficiency of disease control. The “Brown root rot investigation system” and “Fern trees disease monitoring system” were embedded in “Forest disease & pests control, planning and prevention center”. Their data were stored in same data base so users can have higher efficiency in searching, analyzing and monitoring diseases. The services of brown root rot detection and non-destructive detection of trees were also added into the center. Besides, the services provided by the tree medical center are integrated too. From January 1st to December 31st in 2016, a total of 1,646 cases were accepted and consulted by the “Diagnosis and information center of forest diseases and pests”. Furthermore, six tree medical symposiums and eight tree medical work are scheduled to promote the importance of tree health inspection and treatmen.

樹木注射示範。

Tree injection demonstration.

太麻里研究中心生態育林效益監測

Effectiveness Monitoring on Ecological Silvicultural Practices of Taimali Research Center, TFRI

劉一新

I-Hsin Liu

本研究自2012年7月至2015年9月，於林業試驗所太麻里研究中心1998年所建造的原生闊葉樹種混合林內，以自動監測相機對臺灣水鹿之族群動態進行為期39個月、12個監測季的持續監測。經辨識後篩選出410筆有效照片紀錄，並換算為出現指數OI，以分析鹿群分布的區域性差異，以及族群數量的波動情形。分析結果發現：本造林地內的臺灣水鹿，以雄鹿的出現次數較多，約為雌鹿的2.7倍。鹿群的OI值在各監測點間及各監測季間，均呈極顯著差異($p<0.001$)，顯示鹿群在本造林地分布不均勻，且數量呈現季節性的波動。整體而言，鹿群出現於本造林地的數目，呈現穩定增加的趨勢。

This study proceeded in a hardwood mixed stand established in 1998 at Taimalii Research Center, TFRI. Camera traps were used to monitor the population dynamics of Formosan sambar (*Rusa unicolor Swinhoii*) during July, 2012 to September, 2015. After 12 continuing monitoring season of 39 months, 410 effective picture records were identified and composed converted to occurrence index (OI) to analyze the distribution and seasonal fluctuation of sambar's population at different monitoring points. According to the results, the effective records of male sambar was much higher than female's with an occurrence ratio of (♀:♂=1:2.7). Extreme significant variation occurred between both monitoring points and seasons on the OI of sambar's population, showed that the distribution of sambar's population was uneven in the stand and inclined to group at some "hot spot." Meanwhile, the relative abundance of sambar's population was fluctuating and growing stably during the monitoring period.

具綠美化潛能稀有樹木之蒐集與復育

楊正釧

本研究選擇12種稀有且具有綠美化潛力樹種—臺灣粗榧、臺灣三角楓、鐘萼木、四照花、楓港柿、灰莉、臺灣馬鞍樹、烏心石舅、恆春皂莢、湖北海棠、子彈石櫟、臺灣紅豆樹，目的為：(1)明瞭這些稀有樹種種子的發芽條件與機制，以供將來復育育苗之基本參考資料。(2)進行種子儲藏性質研究，即判定其種子是否屬長壽命之乾儲型，以此結果對該種提出未來的保育策略。結果顯示鐘萼木、臺灣馬鞍樹、臺灣紅豆樹與烏心石舅種子不具休眠性，而臺灣粗榧、四照花、子彈石櫟、湖北海棠種子具休眠性，尤以臺灣粗榧及湖北海棠種子具深度休眠。臺灣馬鞍樹種子被乾燥至含水率2.5~11.2%，在-20、4與15℃經二年儲藏後活力仍未有下降趨勢，顯示其能耐乾燥且耐零下低溫環境，故判定其屬長壽命的正儲型，亦即可將種子進行長期儲藏以供日後利用，建議未來以儲存種子來進行本種種源的收集與長期保存時，應先將種子含水率降低到3~7%，然後密封儲藏在-20℃環境中。鐘萼木與子彈石櫟種子不耐乾旱，當含水率被降至25%以下時大部分種子已衰敗死亡，且其對零下低溫非常敏感，而以其能耐4℃的特性，故將其歸類為溫帶異儲型，儲藏鐘萼木與子彈石櫟種子的最好方法是將新鮮種子以4℃濕藏之，於2年內仍能保持原有活力。烏心石舅與臺灣紅豆樹種子則可能屬中間型。

臺灣馬鞍樹的莢果與種子。
Pods and seeds of *Maackia taiwanensis*.

Collection and Preservation of Rare Tree Species with Planting Potential

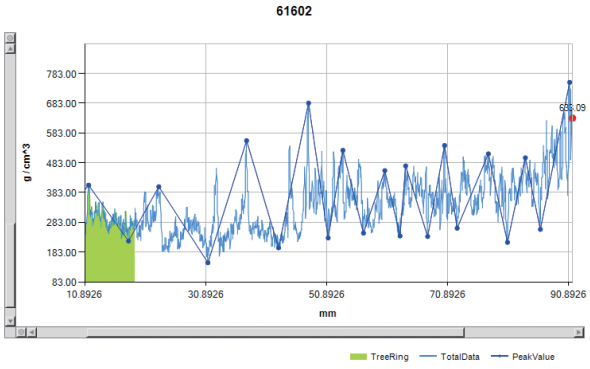
Jeng-Chuann Yang

This study focuses on the seed storability and germination mechanism of the following 12 rare tree species with planting potential: *Cephalotaxus wilsoniana* Hay., *Acer buergerianum* Miq. var. *formosanum* (Hay.) Sasaki, *Bretschneidera sinensis* Hemsl., *Benthamidia japonica* (Sieb. & Zucc.) Hara var. *chinensis* (Osborn) Hara, *Diospyros vaccinioides* Lindl., *Fagraea ceilanica* Thumb., *Maackia taiwanensis* Hoshi & Ohashi, *Magnolia kachirachirai* (Kanehira & Yamamoto) Dandy, *Gleditsia rolfei* Vidal, *Malus hupehensis* (Pamp.) Rehd., *Pasania glabra* (Thunb. & Murray) Oerst., and *Ormosia formosana* Kaneh. The two objectives of this project were: 1) to investigate the germination mechanism and conditions of each species. The result will be a database for restoration and preservation of these endangered species; and 2) to identify the seed storage behavior of these endangered species. If seeds are orthodox, they show long-term seed storability. The results can provide recommendations for conservation strategy of these endangered species. In the study, seeds of *B. sinensis*, *M. taiwanensis*, *O. formosana*, and *M. kachirachirai* are non-dormant while seeds of *C. wilsoniana*, *B. japonica*, *P. glabra*, and *M. hupehensis* exhibit dormancy. Among them, seeds of *C. wilsoniana* and *M. hupehensis* have deep dormancy. Seeds of *M. taiwanensis* still maintained viability when dried to 2.5~11.2% MC (on a fresh-weight basis) after 2-yr storage at -20, 4, and 15℃. Thus, seeds of *M. taiwanensis* can tolerate desiccation and sub-zero temperatures, which is qualified as orthodox. In other words, seeds of *M. taiwanensis* can be stored over a long-term period in the hope of seed supply in the future. When seed storage of *M. taiwanensis* is used for plant germplasm collection and long-term conservation, we recommend that it should be dehydrated to 3~7% moisture content and then hermetically sealed before storage at -20℃. The fresh mature seeds of *B. sinensis* and *P. glabra* were sensitive to desiccation and low temperatures. Most of the seeds lost viability in moisture content below 25%, and seed germinability decreased rapidly at storage temperatures of -20℃. However, seeds of *B. sinensis* and *P. glabra* maintained their initial germinability when stored at 4℃ with moist sphagnum. Thus, seeds of *B. sinensis* and *P. glabra* are defined as having temperate-recalcitrant storage behavior. Additionally, for fresh mature seeds of *B. sinensis* and *P. glabra*, the optimal seed storage condition is wet storage at 4℃, and the initially germinable seeds still had germinability after 2 years. However, seeds of *M. kachirachirai* and *O. formosana* probably represent intermediate seed storage behavior.

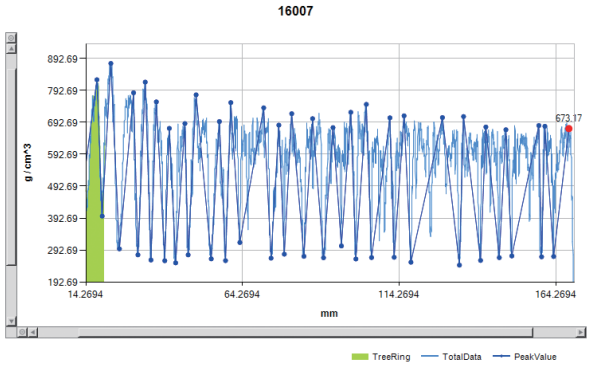
都市樹木危險性的非破壞性檢測及資料庫建立

林柏亨、林振榮

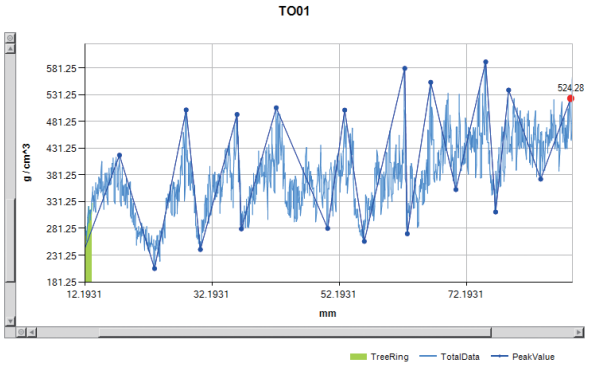
本計畫目前已完成檢查樹木共有27個樹種合計433株，未來將繼續累積不同樹種的樹木檢查，陸續建立樹木檢查的資料庫，已建立目視樹木外觀檢查危險缺點的項目及規範的修訂，建立不同樹種的非破壞性檢測標準參考值，選擇性非破壞性技術使用應力波斷面影像法、橫打擊共振法、微破壞儀法、樹輪密度圖譜法等。已完成15個樹種等檢查樹木的年輪檢測及樹齡評估，應用已完成輔助人工專業樹輪辨識軟體來檢查生長輪及樹輪。



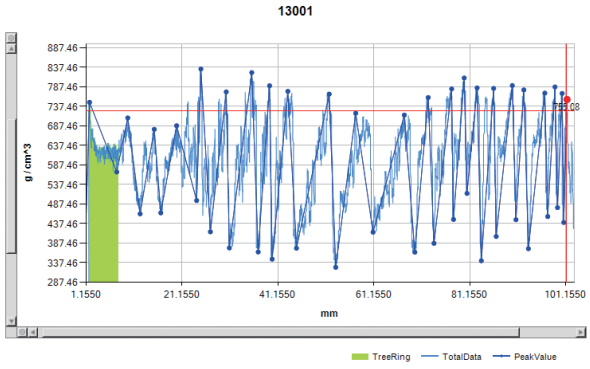
美人樹(no.61602) *Ceiba speciosa*



濕地松(no.16007) *Pinus elliottii*



山黃麻(no.TO01) *Trema tomentosa*



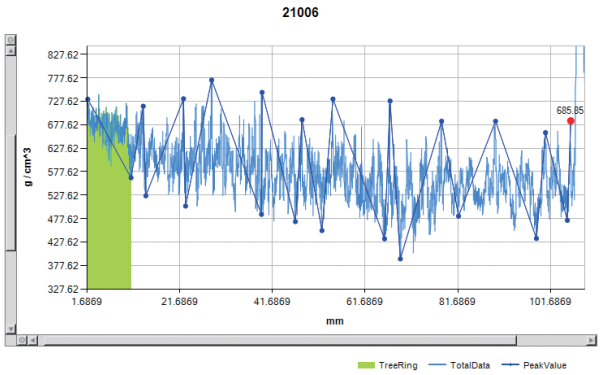
黑松(no.13001) *Pinus thunbergii*

應用x-ray掃描法解析樹輪密度圖譜。
Tree ring profiles in different trees by x-ray tree scanning technique.

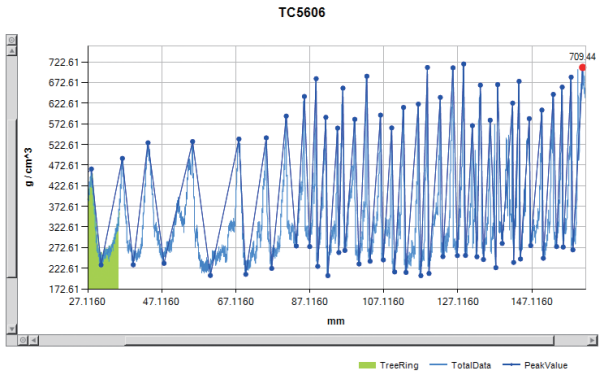
Nondestructive Detection and Database Creation of Urban Tree Age and Risk Assessment

Po-Hung Lin, Cheng-Jung Lin

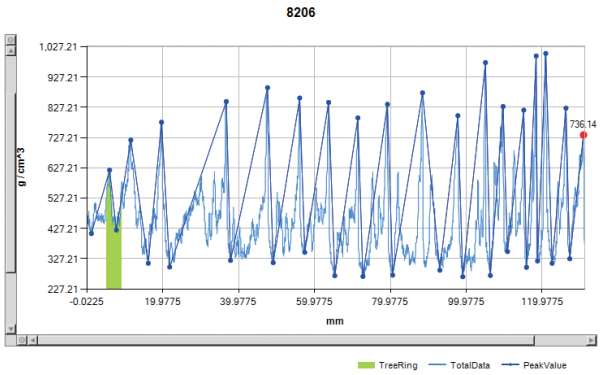
The purpose of this year was to investigate the tree health grades by visual tree assessment under refer to? with reference to international tree management practices. Firstly, the tree medical center of Taiwan Forestry Research Institute provided the tree health service for understanding the tree health grade status by visual tree assessment. The objectives of this project were 27 different tree species and a total of 433 tees. We visually inspected different species of trees and their dangerous shortcomings in appearance characteristics to establish the visual tree inspection database. Secondly, the tree health grades and trunk health were evaluation by different nondestructive techniques, in order to establish a standard database of different species; the evaluation standard parameters of the new technologies that detect tree defects were established. Finally, tree hazard and risk assessment were built and database creation for understanding health grades of tree species based on different levels of standard specification and databases with visual tree assessment and nondestructive techniques. The main purpose of the other project is to detect tree rings and evaluate tree age. For which, 15 different trees were selected and sampled with increment core to produce drill core specimens. Then tree-ring density profile by x-ray scanning technology for tree annual ring. An assistance artificial tree rings software designed professionally was useful in analyzing characteristics of tree rings, and help confirming the age of tree rings.



森氏紅淡比(no.21006) *Cleyera japonica* var. *morii*



臺灣杉(no.TC5606) *Taiwania cryptomerioides*



紅檜(no.8206) *Chamaecyparis formosensis*

林木枝葉生產森林精油

葉若鋆

在林木的成長過程中，為維護森林健康，必須經多次的修枝、間伐等撫育作業，由於林木的培育時間很長，利用林木枝葉生產精油可增加撫育期間的收益，提高林農造林及長期撫育的意願。森林浴具有促進人體健康的功效，林間釋放的芬多精即來自林木枝葉及空氣中的水分、陰離子，居家使用林木枝葉所生產的精油擴香，可達到森林浴的效果。然而，精油的消費並不單取決於精油的療效，精油的氣味與文化、記憶、空間的聯結恐怕才是消費的主要關鍵，將林木枝葉生產的精油與臺灣特有的森林文化相結合，成為具有綠色概念及山林記憶的產品。

針葉樹部分，目前獎勵造林樹種共有10種針葉樹，選取臺灣肖楠、臺灣杉、杉木、香杉、柳杉枝葉進行實驗室精油製備，精油收率以柳杉最高，可達1.54%，遠高於其他樹種精油收率。樟科樹木部分，目前獎勵造林樹種包括樟樹、牛樟、楠木類及肉桂類等樟科樹種，選取牛樟、土肉桂、香楠、香葉樹、山胡椒枝葉進行實驗室精油製備，牛樟枝條精油，含量約為0.3-0.9%，土肉桂葉則以伽羅木醇型的精油收率最高為1.23%，其他樟科樹種則以山胡椒葉部精油的收率最高，可達1.15%。桃金孃科樹木部分，該科樹種目前在獎勵造林樹種的海岸造林及保安林地為白千層，精油含量約為0.37-0.54%。利用枝葉生產的森林精油，不啻具有維護人體健康的功能，更對森林健康有所助益，能為森林概念的載體，傳遞永續森林經營理念給消費者。

林木枝葉生產森林精油。
Production of Forest-Based Essential Oils from Foliar Matters of Trees.

Production of Forest-based Essential Oils from Foliar Matters of Trees

Ruo-Yun Yeh

During the course of forest tree maturation, for the purposes of maintaining forest health and creating desirable tree forms, multiple tending practices of pruning and thinning must be carried out. Due to the long rotational period of forest trees, these provide opportunities of extracting essential oils from foliages of the tending operations to create additional incomes and incentives for foresters to carry out tending operations. The so called "forest shower" has the capacity to improve human health. As the phytocid released by forest trees comes from moisture, anions, and essential oils diffused from foliage. The same can be achieved by placing fresh forest foliages in home for the effect of forest shower. However, consumption of essential oils is not singly determined by their therapeutic quality. The scents of essential oils in association with culture, memory, and spatial elements are probably the critical link to consumption. In this study, we propose to link the essential oil derived from forest tending operations to forest culture to create products with green concept and memories of forest and mountain.

The essential oil yield of Japan cedar (*Cryptomeria japonica*), which was 1.54% higher than that of the other four kinds of coniferous trees. In Lauraceae, the essential oil yield of stout camphor tree (*Cinnamomum micranthum*) twigs was about 0.3-0.9%. Linalool type Indigenous cinnamon tree (*Cinnamomum osmophloeum*) essential oil yield was 1.23%. That of may chang (*Litsea cubeba*) was 1.15%. In Myrtaceae, Cajuput Tree (*Melaleuca leucadendra*) is currently in the reforestation tree species of coastal afforestation and security forest. The essential oil yield was about 0.37-0.54%. In the process, the essential oils so produced shall not only contribute to human health but also the forests where they came from as well. The positive feedback might thus become a carrier to convey the concept of sustainably managed forests to the end users of the forest products.

臺灣商用木材耐久性研究建立

許富蘭、鄧書麟

木材性質優良，應用廣泛。但在風吹雨打日曬蟲咬後，可能產生各種缺點，如顏色變化、變形甚至有安全之疑慮，因此對木材之耐久性有了解之必要。臺灣市面上之木材以進口為主，近年來，因木材輸出國減少木材輸出，因此極需開發新木材來源。然而，這些新木材或其藥劑處理材在臺灣的耐久性資料仍相當缺乏。因此，本試驗於本所中埔研究中心建置田間試驗場(圖1)，埋設已知比重及解剖性質之試材，訂期取回分析，分析項目含質量損失率、顏色變化、生物危害評等。

相思木(*Acacia confusa*)、柳杉(*Cryptomeria japonica*)、大葉桃花心木(*Swietenia macrophylla*)、南方松(*Pinus* spp.)、金檀木(*Bagassa guianensis*)、摘亞木(*Dialium platysepalum*)、婆羅洲鐵木(*Eusideroxylon* spp.) 、太平洋鐵木(*Intsia* spp.)及南洋樨木(*Shorea* spp.)等埋設滿一年之質量損失為：婆羅洲鐵木、太平洋鐵木及南洋樨木最小(<1%)；其次為金檀木(2~3%)、摘亞木、柳杉、南方松(8~10%)；相思木及大葉桃花心木較大(20~30%)。另以加壓法國內目前常用之銅烷基銨木材保存藥劑（ACQ type1）之處理材，埋設滿一年之質量損失為：婆羅洲鐵木、太平洋鐵木及南洋樨木處理材最少(<1%)；而相思木及大葉桃花心木經保存藥劑處理後質量損失降低(3%與6%)；柳杉、南方松處理材更降至2%，此與南方松及柳杉之滲透面積效果好有關。一年接地田野試驗結果顯示，婆羅洲鐵木、太平洋鐵木及南洋樨木的天然耐久性相對較佳，其次為金檀木與摘亞木，而柳杉、南方松、相思木及大葉桃花心木之天然耐久性不佳；木材保存藥劑的處理有利於提升天然耐久性不佳木材之耐久性。本址所埋設之試材數量至少可供10年研究，所得成果為臺灣商用木材耐久性之重要基礎資料。

臺灣商用木材耐久性研究田間試驗場設立於本所（中埔研究中心）。
An exposure field was constructed at TFRI Chungpu Research Center for study on the durability of Taiwan commercial wood.

Research on Durability of Taiwan Commercial Wood

Fu-Lan Hsu

Wood possesses excellent quality and is prized for a multitude of uses. While after exposed to outdoors, wood deteriorate and some problems such as safety concerns may happen. Therefore, it is needed to understand the durability property of the wood in use. Most commercial wood in Taiwan are imported. Due to the reduction of wood export from the wood-exporting countries, new wood sources or domestic plantation wood are urgently needed. However, durability properties of these wood in Taiwan are not well known. Therefore, an exposure field was constructed at TFRI Chungpu Research Center (Fig. 1). Wood stakes with known specific gravity and anatomical properties were installed in the ground, and retrieved periodically to evaluate their mass loss rate, color change, grading decay and termite damage etc.

The results of the mass loss rate for one-year exposure of *Acacia confusa*, *Cryptomeria japonica*, *Swietenia macrophylla*, *Pinus* spp., *Bagassa guianensis*, *Dialium platysepalum*, *Eusideroxylon* spp., *Intsia* spp., and *Shorea* spp. showed that *Eusideroxylon* spp., *Intsia* spp., and Shorea spp were the least (< 1%), followed by B. guianensis (2~3%); *D. platysepalum*, *C. japonica*, and *Pinus* spp. (8~10%); *A. confusa* and *S. macrophylla* (20~30%). Wood stacks were impregnated with ACQ preservatives were also installed in the ground as mentioned above. The results of the mass loss rate for one-year exposure for these treated wood: *Eusideroxylon* spp., *Intsia* spp., and *Shorea* spp were the least (< 1%), followed by *A. confusa* and *S. macrophylla* (3% and 6%) and *C. japonica* and *Pinus* spp. were the most (2%). Results from one-year exposure test showed that *Eusideroxylon* spp., *Intsia* spp., and *Shorea* spp. possess good durability, while poor natural durability can be effectively improved by preservatives. The stacks in the field can offer 10 years of inspection, as accumulating these data is a must for understanding the durability properties of Taiwan commercial wood.

蘭崁山臺灣水青岡境外復育

鍾振德

臺灣水青岡為臺灣保育之固有樹種，分布侷限於北部海拔1,340-2,125m之少數山頂。蘭崁山與大白山兩地，為已知本樹種分布之最東限與海拔最低之生育地，臺灣水青岡在兩生育地的面積分別為0.43與34.29公頃。根據過去之調查，蘭崁山僅存母樹38株，而大白山則超過1,000株。兩生育地臺灣水青岡族群稀少，結實率低，因此計畫目標，主要為進行兩地區臺灣水青岡區外保育。試驗方法包括扦插、嫁接與高壓等3種，以無性繁殖蘭崁山所有38株母樹，以及大白山11株母樹。扦插繁殖試驗，選取試驗母樹新萌芽枝條進行扦插，結果兩地的枝條扦插發根率為0%，顯示成熟的臺灣水青岡母樹很難以扦插繁殖獲取無性品系。初步證實扦插並不適合，嫁接實驗預期可以克服無性繁殖遭遇的困難。本計畫共進行3次嫁接試驗，首先選取砧木與接穗都在冬末休眠時期進行嫁接，結果嫁接成活率僅1.7%，之後的嫁接實驗僅能選取芽綻放後之接穗，6月初嫁接成活率可達17.6%，而最後一次在7月底嫁接，成活率已可達到66.7%。因此，臺灣水青岡嫁接在7月底進行，成活率可以顯著的提升。試驗的三種無性繁殖方法，最後只有高壓最令人滿意。高壓在4月12日完成處理，經過3個月後，大部分處理的枝條都已經發根。結果蘭崁山與大白山枝條高壓發根率，分別為56.5%與48%。本計畫經由無性繁殖試驗，結果蘭崁山94.7%的母樹已經被複製成功，而大白山11株母樹則全部被複製下來。試驗結果初步顯示，嫁接與高壓可以繁殖臺灣水青岡母樹，但扦插則有困難。未來進行臺灣水青岡的母樹復育，方法最好選擇嫁接或高壓。

枝條經過環剝處理包裹水苔，經過3個月後，處理之高壓枝條已經發根。
Wrap the girdled section of limb with moist peat moss covered with a black plastic sheet. After 3 months, treated shoots had already produced roots by air-layering.

Ex situ Gene Conservation of *Fagus hayatae* in Lankan Mountain Area

Jeng-Der Chung

Taiwan beech (*Fagus hayatae* Palib. *ex* Hayata) is an indigenous native tree, which grow only as a few isolated fragments on ridge tops (1,340-2,125m) in northern Taiwan. The Lankan Mountain and Daibai Mountain are known as the most eastern and the lowest elevation habitat of the species. In Lankan Mountain and Daibai Mountain area the tree exist in 0.43 and 34.29 hectares, respectively. According to a survey, there are only 38 Taiwan beech mother trees in Lankan Mountain area, however, there are over 1,000 trees grown in Daibai Mountain. Due to the scarcity of its populations and low rate of seed production, we try to preserve them through *ex situ* gene conservation. The major methods of asexual propagation are cutting, grafting and air-layering. The objectives of the research are to propagate 38 mother trees in Lankan Mountain and 11 mother trees in Daibai Mountain. For the cutting experiment, we selected new growth shoots from the mother tree for stem cuttings. The result showed that the rooting percentage are 0% in the two areas. It indicates that mature Taiwan beech is hard to clonally propagate by cutting. In some respects the method of cutting proved unsatisfactory, cleft grafting is another method to overcome difficulties. We had been tried this grafting experiment for 3 times. Firstly, cleft grafting was done in late winter when both the rootstock and the scion were in a dormant condition. The result indicated that the survival percentage of grafting was only 1.7%. In the second time, grafting was experimented with budburst scion wood in early June. The survival percentage of grafting was 17.6%. At last, when grafting was done in late July, the survival percentage of grafting went up to 66.7%. The graft survival rates have significantly improved and propagation of Taiwan beech in late July. Of all the experiments we tried, only air-layering was satisfactory. Air-layering was carried out on 12 April. After 3 months, most of treated shoots had already produced roots by air-layering. Using air-layering, the mean rooting percentage of mother trees was from 0% to 100%. Thus, the average rooting percentage of air-layering in Lankan Mountain and Daibai Mountain area was 56.5% and 48% respectively. To sum up, through the experiment, we had found that 94.7% of mother trees in Lankan Mountain area were successfully propagated. In addition to propagating Taiwan beech by grafting, air-layering was satisfactory, but not by cutting. It is recommended that Taiwan beech can be propagated from either grafting or air-layering.

新竹科學園區植栽褐根病檢測及防治工作

吳孟玲

新竹科學園區植栽樹木感染褐根病情形近十年來持續發生，未獲得有效控制。本計畫由林業試驗所樹木醫學團隊，針對新竹科學園區植栽樹木及褐根病感染疫區進行病害檢測調查、追蹤及預防檢測，並協助建立分子檢測技術及提供園區樹木褐根病管理防治策略。本計畫重要工作項目包括園區褐根病檢測、防治藥劑施作與協助新竹科學園區建立褐根病快速分子檢測技術三大項。工作目標包括完成園區施作樣區定位、樣樹編號並設置標牌，本年度完成兩次採樣、培養與分子檢測及完成三次採樣與培養、防治藥劑施作與樹木施藥前後生長勢記錄。另外，本樹醫團隊辦理兩次褐根病快速分子檢測技術講習及一次根部藥劑加壓灌注技術施作示範講習，協助園區建立褐根病檢測技術與藥劑防治作業程序。最後，本團隊根據各株樹木感染情形、生長情形與環境條件提供個別防治建議(共六區，100株樹)，感染褐根病後期之樹木應盡速完成樹體及病根移除，並進行土壤消毒作業；初期病徵及鄰近感染後期之樹木，應持續施用藥劑灌注及定期追蹤檢測，並持續觀察樹勢生長恢復情形。建議未來園區褐根病防治首要進行四大行動：一、園區樹木普查。二、將園區褐根病發生熱點，分為高、中、低風險區，訂定不同之防治方法及策略。三、竹科團隊褐根病監測防治團隊養成，及行動。四、園區褐根病防治作業推行。

辦理褐根病快速分子檢測技術講習情形。
Classes are held to demonstrate molecular detection technology for brown root disease.

Inspection and Treatment of the Brown Root Disease Infection of Trees in Hsinchu Science Park

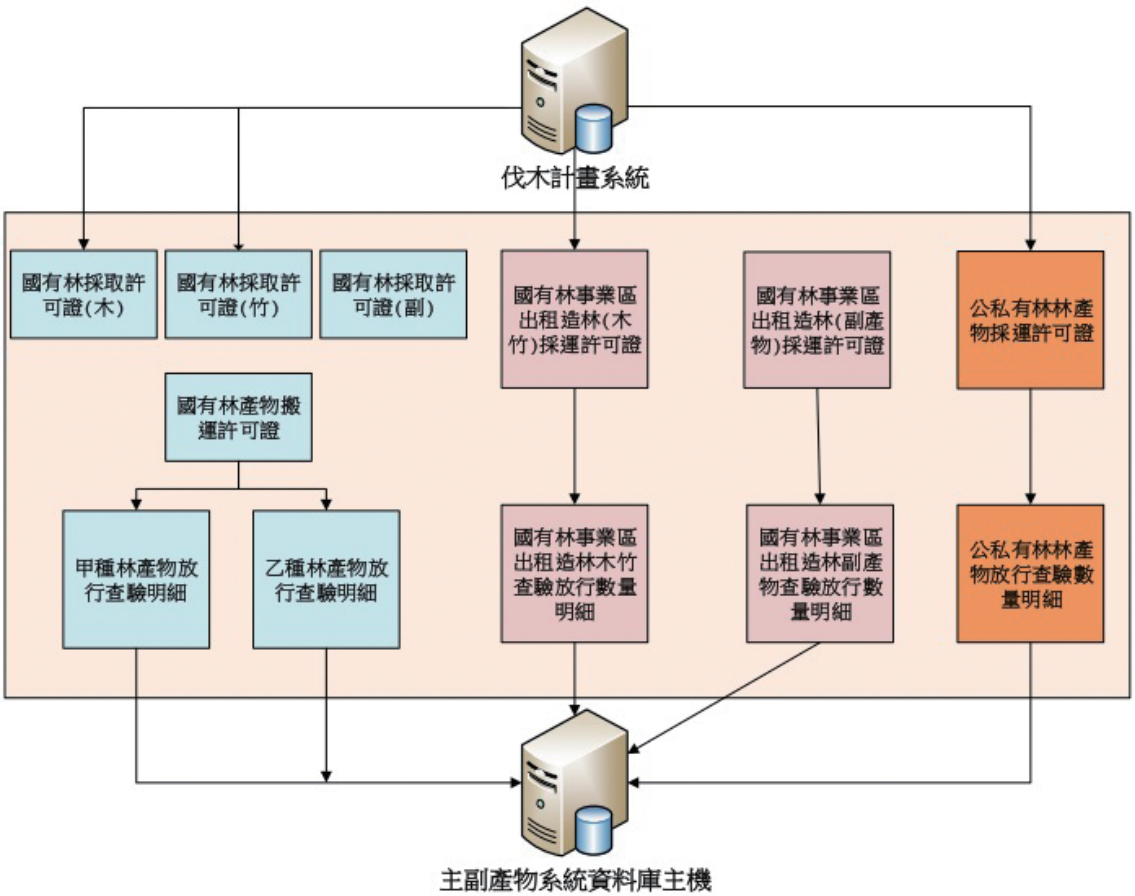
Meng-ling Wu

The brown root disease infection of the trees in Hsin-chu Science Park is prevalent in recent ten years and has not been effectively controlled. In this project, the tree medicine team of Taiwan Forestry Research Institute (TFRI) was invited to conduct disease investigation, tracking and prevention detection for the brown root disease in Hsin-chu Science Park. The purpose of this study is to assist in the establishment of molecular detection technology, and to provide the advice of management and control strategy of brown tree root disease in this park. Three critical parts of this project include: 1. the detection of brown root disease in the park; 2. the treatment of control chemicals; and 3. the assistance in the establishment of rapid molecular detection technology of brown root disease. The objectives of the work include the sample areas positioning, sample trees numbering and signage, completion of sampling, cultivation and molecular test for 2 times and completion of chemical control treatments and growth situation records before and after treatments for two times. In addition, our tree medicine research team has arranged two molecular detection technology classes and one root pressure perfusion technology demonstration for brown root disease, to help assist the park organization to build related technology and pharmaceutical treatment procedures. Finally, our team provided individual control recommendations according to the tree infection status, growth situation and environmental condition (six areas, 100 trees in total). The seriously infected trees of the park should be removed as soon as possible. The soil needs to be sterilized; The trees with early symptoms and those adjacent to infection zones should receive chemical treatments and be periodically follow-up detected, and observed for the recovery. We suggested four main actions that need to be done in the future. Action 1: a general survey of trees in the park. Action 2: flagging the disease hot spots in the park, rating high, medium and lowing risk areas, and setting up different control methods and strategies. Action 3: training monitoring and control team of Hsin-chu Science Park for brown root disease. Action 4: exing control operations in Hsin-chu Science Park against brown root disease.

國產材生產體系評估、資訊系統建置及產銷分析

湯適謙、謝漢欽

由於落實森林永續經營的森林認證及抑止非法砍伐之議題逐漸受到國際重視，因此為確保國產材均為合法來源，以提高其競爭力，須正確掌握國產材之生產資訊。本計畫執行之目的為完成國產木、竹材生產資訊系統建置，與目前農委會林務局「採伐計畫管理作業系統」及「森林主副產物系統」結合，相關資料可自動拋轉，且具自動產生季報表之功能。並可與核發採取及搬運許可證作業連結，自動核發許可證。為配合資訊系統之列印及資料匯入，修正目前之相關表單，並於許可證上納入QR code (Quick Response code) ，以判讀資料；亦請各相關單位提供建議事項及試行操作。本年度亦將所建置之系統納入地理資訊系統，提供各伐採預定案之空間資訊。將各林業經營單位歷年國、公私有林木材與竹材生產資訊依樹種別、單位別及年度予以分析，整理從78~104年度林務局各林管處和各縣市政府農林單位的木材和竹材生產之總數量；本計畫亦完成「漂流木倉儲管理資訊系統」之建置，未來管理單位可使用系統網頁填報漂流木的數量、規格和執行搬運許可證的核發。本研究所開發之系統亦具資料查詢、統計分析之功能。另外對近年來林務局各林管處之國產材標售業者進行問卷調查訪談，以了解業界之需求及國產材之使用現況。



林產物生產及發證管理資訊系統之系統架構。
The systematic framework of forest products and license-issuing management information system.

Evaluation of Domestic Wood Production, Establishment of Information System and Analysis of Production and Marketing

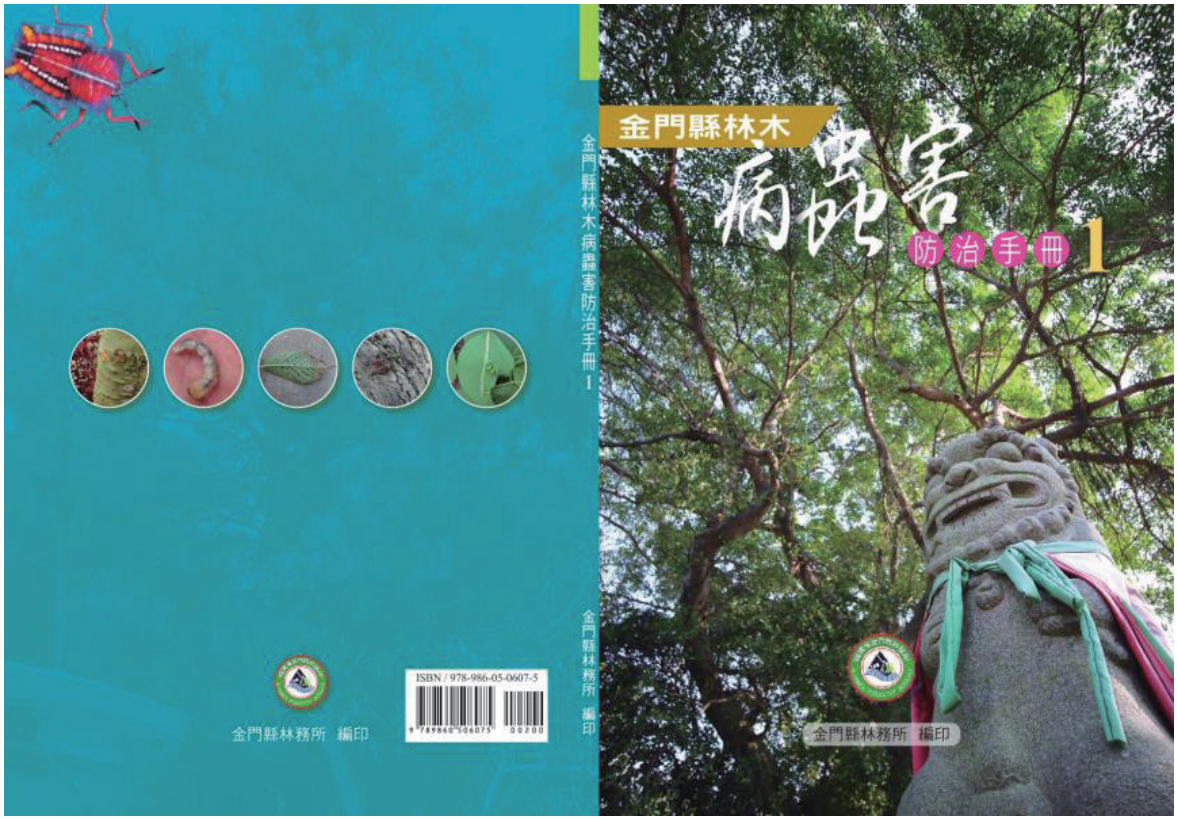
Shyh-Chian Tang, Han-Ching Hsieh

The issues of forest certification for implementing sustainable forest management and suppressing illegal cutting are getting more attention internationally. So, it is important to grasp the domestic wood information correctly to make sure the legal sources and enhance the competitiveness. The purpose of this project was to establish the domestic wood and bamboo production information system. It can be combined with the "Logging plans management system" and "Forest primary products and by-products system" developed by the Forestry Bureau, Council of Agriculture, to switch data automatically and generate quarterly reports. The licenses of harvesting and wood transportation could be connected to be issued automatically. In order to assort the printing and data importing for the system, the present related forms should be revised and the QR code (Quick Response code) be fitted to read the data. The related units were requested to provide suggestions and pre-operate the system. The geographic information system was included in the system this year, and the geospatial information of preordaining logging plans can be provided. The annual wood and bamboo production information for forest management units could be analyzed by species, units and years. The total wood and bamboo productions for the Forest District office of Forestry Bureau and the agriculture–forest departments of county governments were organized. The "Warehouse management information system of driftwood" was built also. Management units can use the system to fill in the volume and size of driftwood and issue the transportation licenses. The system developed by the project can be used to information sorting and statistical analysis. On the other hand, the contractors who bade the domestic wood of Forestry Bureau in recent years were interviewed by questionnaires. The demand of wood industry and the utilization situation of domestic wood could be realized and analyzed.

金門縣林木病蟲害調查及防治建議

吳孟玲

金門全縣道路綠廊生態完整，可吸引許多昆蟲取食並繁衍下一代，另一方面卻會造成部分病蟲害大量發生，除影響林木健康外，也容易引發當地民眾恐慌。為維護這得來不易的綠色資源，須透過完整的病蟲害調查，來擬訂合適的樹木健康管理策略。本計畫共完成金門全縣155株列管珍貴老樹，以及18條主要道路、40條次要道路、19處公園與29所學校所栽種林木的普查，藉此追蹤全縣病蟲害發生地點及受害程度，並依照病蟲害發生的情形，給予適當的防治建議，包含非農藥防治方法及建議使用之農藥。其中155株列管珍貴老樹，並依本團隊所建立的樹木健康檢查表格，逐一進行病蟲害與健康狀況之評估，建立每株樹木的健康診斷表，並依據診斷表的內容，作出風險評估及處置建議，以提供珍貴樹木的綜合健康管理參考。最後根據現地調查的結果，挑選出金門地區重要的22種病蟲害，包含褐根病、靈芝根基腐病、黑翅土白蟻、綴葉叢螟及刺桐釉小蜂等，將其主要寄主植物、危害方式、病徵、形態特徵、發病生態、生活史及防治方法等資訊彙整編撰，出版《金門縣林木病蟲害防治手冊》1本，供現場施作人員參考。同時並透過辦理2場防治講習訓練，以及金門地區林木病蟲害調查資料庫的建置，來大幅提昇病蟲害的防治成效，藉此強化金門地區的林木健康。



出版《金門縣林木病蟲害防治手冊》。
The manual 《Tree Pests and Diseases Control Manual in Kinmen》 was published.

Pests and Diseases Survey and Control Recommendations for the Trees of Kinmen County

Meng-ling Wu

The ecosystem resource of urban forest in Kinmen County is rich and characteristic; however, it suffers from various pests and diseases, which affect tree health and induce the fear of environmental deterioration. Therefore, developing an appropriate tree health management strategy is necessary. In this project, a total of 155 precious trees, as well as trees on the 18 major roads, 40 secondary roads, 19 parks and 29 schools in Kinmen were surveyed. According to the location and the degree of damage, specific control recommendations were provided, including non-pesticide control methods and the proposed pesticides. The health conditions of 155 precious trees were assessed by the assessment form established by the research team. Following that, the risk assessment and treatment recommendations were provided. Based on the results of survey, a total of 22 critical diseases and pests in Kinmen were selected, including brown root disease, termites, leaf borer and gall wasps. The team then collected the information about the main host plants, morphology, symptom, life cycle and control methods of these species, and published a manual《Tree Pests and Diseases Control Manual in Kinmen》. In addition, two training courses were scheduled and the survey database was established to enhance the effectiveness of the tree health management in Kinmen.

臺中市105年度老樹樹木褐根病防治效果追蹤計畫

張東柱、傅春旭

臺中市泉源公園老榕樹嚴重罹患褐根病，市政府已委託樹保工作者從事棲地改善及施用生物防治，但病害仍未改善，市政府因而委託本所進行防治效果追蹤監測。執行項目包括：利用非破壞性儀器進行樹木傾倒風險評估，每個月採取土壤及根部樣本已確定褐根病的活性，土壤樣本是利用褐根病偵測犬偵測，根部樣本以選擇性培養基進行培養分離。測定營養液及生物防治藥劑對褐根病菌生長及存活影響。執行結果與結論：(1)泉源公園老榕樹已嚴重罹患褐根病，因此無須做非破壞性檢測。(2)泉源公園老榕樹根部經6、7、8、9月(105年)的採集樣本進行分離培養，褐根病菌的檢出率均未降低，且9月採樣時老榕樹已完全枯死，顯示營養液與殺菌劑的處理並未有效抑制褐根病菌的活動及提升老榕樹的健康狀況，該處理應屬無效。(3)在實驗室測試營養液及殺菌劑對褐根病菌生長影響，結果顯示，有三種營養液(1、2、6 號)不但沒有抑制褐根病菌生長，還在有些濃度有促進褐根病菌生長。另外兩種營養液(5、7號)有程度上的抑制作用。殺菌劑在高濃度下有抑制褐根病菌生長，但不具殺菌作用。(4)在實驗室利用感染枝條測試營養液及殺菌劑浸泡對褐根病菌存活影響，結果顯示，營養液對感染枝條褐根病菌的活性沒有抑制作用，經營養液處理過的枝條，褐根病菌的活性並未受到減弱。殺菌劑的處理有程度上的殺菌作用，但在實地施用並未達效果，可能是因為在實地施用藥劑時，殺菌劑無法完全接觸到病原菌有關。(5)泉源公園老榕樹已死亡，建議移除，並依褐根病危害樹木之處理程序，進行樹木移除與土壤處理。

臺中泉源公園罹患褐根病的老榕樹。
The eld Ficus microcarpus infected with brown root rot at Chuen-Yuen park in Taichung.

Detection of the Effect in Disease Control of Brown Root Rot Caused by *Phellinus noxius* on an Old *Ficus microcarpus* Tree in Taichung City

Tun-Tschu Chang, Chuen-Hsu Fu

An old *Ficus microcarpus* tree, which was infected with brown root rot caused by *Phellinus noxius* at Chuen-Yuen park in Taichung, was treated with some kinds of biological control solutions and health improvement ingredients. However, the condition of the diseased tree has not improved. The city gov-ernment therefore initiated a detection project to Taiwan Forest-ry Research Institute. The aims of the project were to evaluate the safety of the tree by non-damaging equipment, to collect the soil and root samples and detect the activity of the pathogen, to test the biological control solutions on the effect of the patho-gen in growth and survival. The results and con-clusions were as follow: The disease on the *Ficus microcar-pus* tree was so server, that there was no need to carry out the non-damaging test. The detection rates of *P. noxius* in infected roots did not decrease in four separative collections from June to September, 2016; and the tree was dead by September, 2016, indicated that the treatment had no effect on inhibiting activity of the pathogen and on im-proving resistance of the tree. In the petri-dish test, the biologi-cal control solutions number 1, 2 and 6 did not inhibited but im-proved the growth of the pathogen. Other two solutions (number 5 and 7) had slightly inhibited the growth of the pathogen at higher concentrations. In the lab tests, all biological control solutions did not decrease the sur-vival rates of the pathogen. Because the old tree was dead and was infected by *P. noxius*, it is suggested that the tree should be removed completely and followed the SOP treatment for tree infected by *P. noxius*.

人工林不同林況以不同疏伐方法之採運作業研究

湯適謙、邱志明

為了解人工林疏伐作業之作業效率及提供制訂標準工作量之參考依據，本計畫以行政院農業委員會林務局8個林區管理處，19個作業地為對象，進行疏伐作業之伐木造材、集運作業之工作研究及成本分析，探討各作業單元之作業時間及分配比例，初步分析結果為，因地況、林況不同，其中伐木造材作業平均每株樹平均作業時間為218~1,178sec，平均為527sec，其中準備收拾所佔比例為1.3~32.3%，平均8.6%，實際作業所佔比例為52.4~90.2%，平均77.7%，寬裕所佔比例為3.4~29.8%，平均13.6 %；集材作業平均作業時間為373.1~1,502.7sec，平均827.2秒，其中準備收拾所佔比例為5.0~38.4%，平均13.8%，實際作業所佔比例為33.4~76.3%，平均60%，寬裕所佔比例為6.6~55.9%，平均26.2%。疏伐作業總平均單位成本在竹東事業區第2林班為2,721.2元/m^3、巒大事業區第90林班為2,905.7元/m^3、關山事業區第5、6林班為3,185.2元/m^3、竹東事業區第87林班為3,296.8元/m^3。

另外藉由「不連續差數重要度指數原則」得知影響伐木造材、集運作業各因子之相對權重(重要度)，其中伐木造材以「林地坡度」及「平均疏伐單木材積」為影響伐木造材作業權重最高之因子；集材作業則以「平均疏伐單木材積」為影響疏伐木集材作業工作量權重最高之因子；根據平均日工作量及重要度分析結果可求得伐木造材及集材作業之日標準工作量方程式如下式：

伐木造材作業：$Di = 0.129\ Xi(1-\alpha\%)$

集材作業：$Di = 0.048\ Xi(1-\alpha\%)$

Di：日標準工作量(m^3/day/man)，Xi：工作量指數合計，α：寬裕率。

林務局臺東林管處關山事業區人工林疏伐造材作業。
The bucking operation of plantations thinning in Guanshan working circle, Taitung Forest District office, Forestry Bureau.

Work Study on the Logging Operations for Thinning Plantations of Different Factors

Shyh-Chian Tang, Chih-Ming Chiu

In order to realize the operational efficiency of plantation thinning and provide the reference basis for standard outputs, this project was undertaken in 19 operations areas of eight districts of Forestry Bureau, Council of Agriculture. The work study for the felling-bucking and logging of thinning was applied to investigate the operational time and percentage of work unit. The preliminary analysis results were as follows:

For the felling-bucking operations, the average operational time for each stand tree was 218~1,178 sec, average 527 sec; the proportions for preparation packing, practical operation, and allowance were 1.3~32.3%, 52.4~90.2% and 3.4~29.8%, respectively. On the aspect of logging, the average operational time for each logging cycle was 373.1~1,502.7 sec, average 827.2 sec, the proportions for preparation packing, practical operation, and allowance were 5.0~38.4%, 33.4~76.3% and 6.6~55.9% respectively. The average unit operational cost for the No.2 compartment of Zhudong circle, No.90 compartment of Luanda circle, No.5-6 compartments of Guanshan circle and No.87 compartment of Zhudong circle were 2,721.2 NT/m^3, 2,905.7 NT/m^3, 3,185.2 NT/m^3 and 3,296.8 NT/m^3 respectively. On the other hand, by the "principle of discontinuous difference for weighted index," the weights of factors affecting felling- bucking and logging operations were estimated. For the felling-bucking, the most important factors were "slope" and "average volume of stand." On the aspect of logging, the most important factor was "average volume of stand." The standard output formula here was obtained by averaging the productivity and weight indices of factors. The equations were as follows.

The felling-bucking operations: $Di=0.129\ Xi\ (1-\alpha\%)$

The logging operations: $Di=0.048\ Xi\ (1-\alpha\%)$

Where, Di: daily standard output (m^3/day/man); Xi: summation of indices; and α: allowance rate

使用架空索將圓木舉高進行集材作業，可降低林地之衝擊。
The usage of skyline to lift the woods for logging can reduce the impact of forest land.

新竹市珍貴老樹健康檢查暨樹木保護計畫

傅春旭、林文薇、劉芳孜、陳致麗、林芳瑜

2004年依照「新竹市樹木及綠資源保護自治條例」公告列管珍貴老樹共103棵。陸續因病蟲害、颱風及公共安全因素解除列管12棵、本計畫共檢查91棵新竹老樹，其中4棵死亡，分別是編號016龍眼、017龍眼、043榕樹及編號039榕樹。其中龍眼為移植導致枯萎，檢視其移植計畫書，似乎有移植步驟需要檢討。編號043榕樹及編號039依照現場殘根判斷為樹木褐根病所引起之枯萎傾倒。榕樹編號052榕樹所在位置大門深鎖及編號107香椿所在位置在廢棄房屋內故無法進入檢測。在病蟲害調查發現其中2棵老樹附近有樹木褐根病，需要針對周圍感染褐根病之樹木進行防除以避免感染；4棵老樹遭受靈芝感染需進行外科手術處理；編號007日本黑松需要每年進行松線蟲藥劑預防處理；4棵老樹遭受經常性不合理的強修剪已嚴重危及樹木健康；以非破壞性檢測進行樹幹圓盤分析顯示大部分老樹的樹幹腐朽呈現中度到嚴重的程度，需要分級進行處理加強結構性支撐以確保人樹安全；同時多數的老樹其生育地受限嚴重，迫切需要進行生育地改善；白蟻危害普遍，需要積極防除；為維護刺桐老樹健康生長，釉小蜂需積極防除，樹冠內枯枝或斷落枝條高掛容易引發公共危險，建議應立即移除。少數老樹周圍環境髒亂，有雜物及垃圾堆積，甚至有惡臭，這樣的環境讓民眾無法親近老樹，建議管理單位應加強環境整理，使民眾能親近老樹。

受保護樹木健康檢查。
The healthy examination of defended tree.

Health Examination and Protection Plan of Hsinchu City Precious Old Trees

Chuen-Hsu Fu, Wen-Wei Lin, Fang-Tzu Liu, Chih-Li Chen, Fang-Yu Lin

One hundred and three precious old trees were announced according to “Hsinchu city autonomous regulations of old trees and green resources protection” on 2004. Twelve precious old trees are cancelled one after another from the list due to pests and diseases, typhoon as well as public safety concerns. Ninety-one old trees were examined in this project. Of these, 4 precious old trees (No.16, No.17, No.43, and No.39) were dead; No.16 and No.17 died due to the transplantation; No.39 and No.43 died due to the brown root disease. Whereas No.52 and No.107 could not been examined because the door to the premise was locked and the obstacle of wastes. There are 2 old trees are on the verge of brown root disease infection because of the disease debris nearby. Control measures of brown root disease have to be done to avoid infection. Four old trees have to be surgically treated to control the infection of *Ganoderma* sp. No.7 red pine need to be treated with pesticide to control pine nematode every year. Four old trees are damaged by incorrect pruning. Most of the old trees are rotten in the trunk according to the analysis of trunk ring, and may pose danger to the nearby inhabitants. Damage by termites is so prevalent and need to be controlled. In order to maintain the health of India coral trees, a pest, *Quadrastichus erythrinae* Kim, needs to be actively control,. Dead or broken branches hang on the crowns are liable to cause public hazard and is recommended to be removed immediately. The surrounding environment of some old trees is dirty, and there are debris and garbage accumulation and even stench in the air nearby. It is recommended that the management unit should strengthen the environmental management so that the people can get close to the old trees.

松園別館樹幹非破壞性檢測研究計畫

傅春旭、張東柱、林文薇、劉芳孜

松園別館的松樹為1921年種植的琉球松(*Pinus Luchuensis*)，初植時為10年生小樹，故目前樹齡已超過100年。原有64棵，但因病蟲害肆虐，加上天候如颱風的侵襲，至2014年，只剩下31棵。為維護這31棵珍貴的老松樹，故花蓮縣政府委託本所針對樹木內部腐朽情形進行非破壞性檢測。同時將相關病蟲害進行調查。本次結果發現每一棵老松樹樹幹皆有中空腐朽的現象，僅編號07、11、16、17、29、35、39及50號較輕微，其他樹木樹幹圓盤分析皆呈嚴重腐朽或是蛀蝕的現象。以生長錐進行鑽探採樣，採樣的結果與圓盤分析比對，象徵蛀蝕或是腐朽嚴重的部位應該是白蟻蛀蝕所形成的蟻道；以採樣的木材進行選擇性培養基進行培養並未培養出任何木材腐朽菌，加上以往老松樹傾倒或是枯萎砍伐後樹幹蛀蝕狀態評估，松園老樹松樹幹內部危害主要以受白蟻蛀食為主。故防治白蟻及依照樹幹內部蛀蝕嚴重程度進行強化結構性支撐，是保全珍貴松樹最重要的工作。其他重要病害以松材線蟲、靈芝根基腐朽最為重要。松園老松樹因為每年皆有進行松材線蟲防治工作，故周邊老松樹遭受松線蟲危害枯萎的情形並不會在松園發生。靈芝根基腐發生在編號9號與10號間的殘留老松樹之樹頭，早期該株老松樹因南方靈芝感染而風倒，殘留的根頭上已經有子實體產生，建議應該移除病殘根，避免感染相鄰之老松樹。松樹梢枯病及葉震病主要發生在新補植的松樹上，為避免好樹遭受感染應加強防治降低感染源。老樹周邊土壤硬度皆在2~4kg/cm^{2}之間並無土壤夯實的情形，主要是園區管理內禁止踩草皮較少有人為及行車踩踏壓夯實的情形。

樹幹腐朽嚴重的松樹以鋼架支撐。
The old pines with serious rotten trunk were support by steel frame.

Non-destructive Detection on the Trunk of Old Pine Trees in the Pine Garden

Chuen Hsu Fu,Tun-Tschu Chang, Wen-Wei Lin, Fang-Tzu Liu

Pine trees (*Pinus Luchuensis*) PG better care on these treasured old pine trees, Hualian Government ask TFRI to be a contract research organization and to proceed with non-destructive inspection of the trunks of old pine trees and a pest and disease investigation. The results of research show that every old pine tree is rotten in the trunk and there are only 8 old pine trees (No. 07, 11, 16, 17, 29, 35, 39 and 50) has little rotten in the trunk. Trunk ring analysis shows there are serious decay in trunk in most of old pine trees. According to the data of trunk ring analysis, the wood samples in the trunk were taken with a sampling drill. Checking of these wood core samples indicate the decay may be caused by termites. There was no suspicious wood decay fungus cultured on a selective medium. In addition, there was other evidence that there were serious damage by termite in the earlier trunks of typhoon felled and cut wilt old pine trees by the pests. Thus, major damages in the old pine tree trunks are due to feeding of termites. Control of termites and intrinsic strength of old pine trunks are the most important considerations in protecting these treasured old pine trees. Pine nematode and *Ganoderma* buttery? control is also important. Due to an annual defending plan against pine nematode disease, there is no such problem in the Pine Garden. There are fruiting bodies of *Ganoderma australe* (Fr.) Pat. on the residual roots between No.9 and No.10 old pine trees. The infected residual roots have to be removed and infected soil be fumigated in order to protect other healthy old pine trees. Soil hardness test (2~4kg/cm^2) shows there is not much solidification in the soil around the pine trees, and it could be due to good management of the Pine Garden to avoid treading of people and cars.

金門行道樹樹木非破壞性檢測

邱志明

都市樹木提供淨化空氣、調節氣候、景緻及生態等多重效益，為人們所關注之焦點，因此，行道樹都市林木之健康及安全評估扮演著重要角色，尤其對交通繁忙民眾活動之熱點。樹木之健康及風險管理，重點在瞭解樹木生長環境、樹幹、樹冠、樹根等生長狀況，藉由目視評估及非破壞檢測，預知和判定潛在可能之危險而加以防範，金門縣政府林務所非常重視其轄區內重要道路樹木之安全，因此委託本所分年進行檢測。

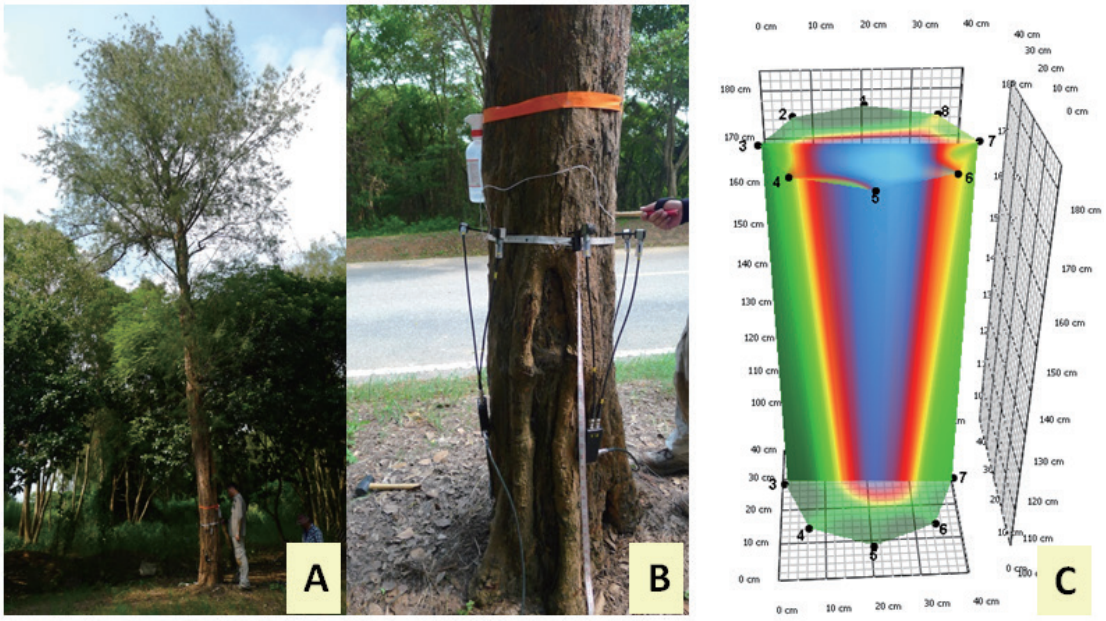
本年度進行經武路、瓊安路、雙瓊路及堡山路四條道路，胸徑30cm以上林木為調查對象，進行編號及掛牌。共調查經武路100株，瓊安路335株，雙瓊路100株，及堡山路156株，共691株，13種樹種。主要為木麻黃583株，其次為大葉桉62株，小葉南洋杉12株，其餘皆在10株以下。

經目視結果區分，立即危險需伐除的13株，佔1.9%，暫無危險378株，佔54.7%，需以非破壞檢測確認的有300株，佔43.4%。

目視評估常見的缺點有：1.修枝傷口或腐朽、2.蟻害、3.腐朽孔洞、4.樹皮受損、5.主幹劈裂、6.長子實體、7.樹幹或樹冠傾斜、8.根系裸露等。

在已完成非破壞檢測(NDE)之214株中，安全的有84株，佔39.3%，暫無危險61株，佔28.5%，有危險之虞31株，佔14.5%，危險38株，佔17.8%，經目視評估和非破壞檢測綜合評估共計建議伐除48株，佔整個目視評估687株之7.0%。

莫蘭蒂颱風對本路段，經統計冠損585株（85.2%），幹折57株（8.3%），傾倒45株（6.5%），比對VTA和NDE綜合評估，幹折3m以下準確率100%，幹折3m以上準確率76%，傾倒準確率53.3%，偏低之原因，林木健康和樹幹根部結構安全，無法劃上等號。



木麻黃行道樹 (編號183)，目視外觀評估及非破壞檢測樹幹二斷面(1.0和1.8 m)，所顯示出之3D影像(中心藍色部分為樹幹嚴重腐朽，紅色部分劣化，綠色部分健全)。

The street tree (*Casuarina equisetifalia*, no.183) was evaluated by VTA (A) and NDE for two cross section (1.0&1.8 m) of trunk (B) and the 3D tomograph of within trunk C. (blue color display serious decay, red color display deterioration, green color display the health)

Non-destructive Evaluation of Street Trees in Kinmen

Chin-Ming Chiu

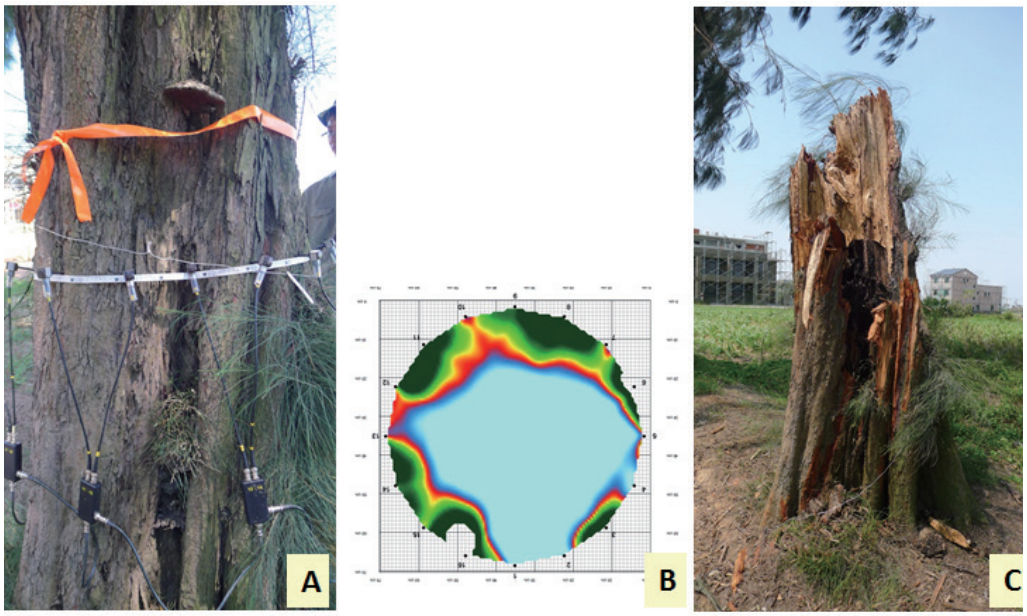
Urban trees moderate climate, provide purified clean air, landscape views, ecological functions and many other benefits. Hence, street trees and urban trees interact in public safety and tree risk management is an important issue for the modern society. Tree risk assessment is the process of evaluating the likelihood that part or all of a tree will fail and cause damage and/or injury to humans and/or properties. Tree health and tree hazard assessment are based on Visual Tree Assessment (VTA) and Non-destructive Evaluation (NDE).

When evaluating a tree, we must first diagnose the tree's exterior appearance, such as tree crown, trunk, roots and growth environmental conditions. However, when defects within tree trunk are suspected and we can't judge by visual inspection, we have to use NDE assessment. Kinmen forestry bureau pay much attention to tree health and the street trees in Kinmen County, and entrusted TFRI to evaluate the street trees year by year.

We evaluated the trees with DBH more than 30cm and the results showed that there are 100, 335, 100, and 156 trees respectively on Jingwu Rd. , Qiongan Rd. , Shuangqiong Rd. and Baoshan Rd. in Kinmen county this year. A total of 691 trees belonging to 13 species are examined. The main species, *Casuarina equisetifalia* comprises 583 trees; the next are 62 trees of *Eucalyptus robusta*, 12 trees of *Araucaria cunninghamii*, and all the rest of species are less than 10 trees. Through VTA survey, the results indicated that 13 trees (1.9%) were extremely dangerous, need to be cut imminently and 378 trees (54.7%) were moderately dangerous. There were 300 trees suspected of having defects need to be identified by NDE, accounting for 43.3% of the total.

VTA of the common shortcomings are: 1) pruning wound or decay; 2) ants; 3).decay cavity; 4) bark damage; 5) trunk split; 6) fungal fruiting body; 7) leaning trunks or wind-fallen; and 8) lifting of root plates and so on. Of the trees that had completed NDE evaluation suggest that 84 were safe (39.3%), 61 somewhat danger (28.5%), 31 probably dangerous (14.5%), and 38 having imminent danger (17.8%). Of the trees evaluated by VTA and NDE, a total of 48 trees were recommended to be cut, which accounted for 7% of 687 trees examined by VTA.

Invasion of Kinmen by Typhoons Moranti in September 15, 2015, provided us an opportunity to verify the results. Typhoons Moranti resulted in 585 (85.2%) cases of canopy damages, 57 (8.3%) cases of trunk damages and 45 (6.5%) cases of trunk leans. Compared to the VTA and NDE, the accuracy of the assessment was 100% for trunk damage of trees with < 3m trunks, 76% for trees with > 3m trunks, and 53.3% for trunk leans.



木麻黃行道樹颱風前經NDE檢測(A)，顯示之斷層影像(B)和莫蘭蒂颱風侵襲後，樹幹受損之狀況(C)。(編號129)。
The street tree (no.129) was evaluated by NDE (A), showing the tomograph (B) and then trunk was damaged by Moranti typhoons(C).

105年中正紀念堂定期樹木健全性檢查

Inspection of Periodic Tree Structural Safety at National Chiang Kai-shek Memorial Hall in 2016

林柏亨、林振榮

Po-Hun Lin, Cheng-Jung Lin

本計畫完成園區目視樹木評估共1,500株，及目視樹木結構缺點七大項，應用2D應力波非破壞性法檢測樹木共有205株，已經完成計畫檢查樹木的目標。最嚴重危險等級，建議先進行減輕樹木風險處理。白蟻及腐朽是樹木危害的主要原因，建議進行防治及管理。

The purpose of this project was to investigate the tree hazards assessment of living trees in the National Chiang Kai-shek Memorial Hall to provide tree management guidelines. The project completed a total of 1,500 trees in the park and visual shortcomings of the seven major tree structures by visual tree assessment (VTA). A total of 205 trees were inspected by 2D stress wave nondestructive technique (NDT). The plan has been completed to check for the trees' objectives by VTA and NDT. For the most serious risk levels, it is recommended to reduce the risk with tree treatments. Termites and decay are the main causes of tree damage, prevention and management is recommended.

目視樹木評估法判斷樹木危險等級。

The hazardous grades in living trees by visual tree assessment.

國立國父紀念館中山公園樹木危險性檢查及評估

Inspection and Evaluation of Tree Hazards in National Dr. Sun Yat-Sen Memorial Hall

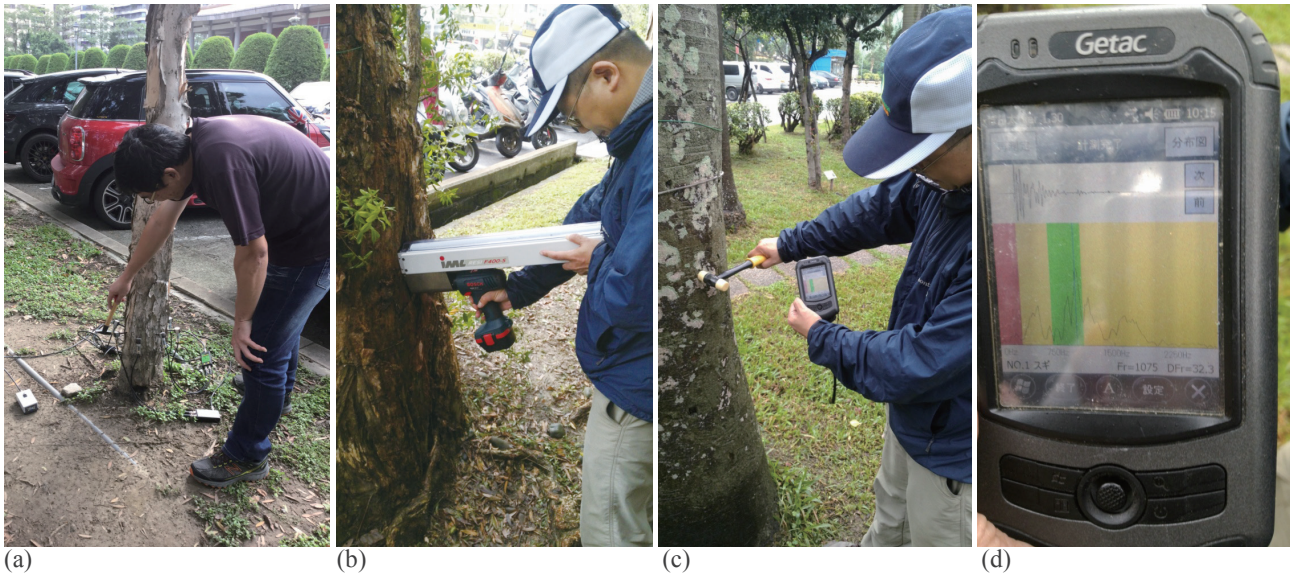
林柏亨、林振榮

Po-Hun Lin, Cheng-Jung Lin

本計畫共完成調查園區白千層及大王椰子樹種，目視檢查共151株，目視樹木結構缺點七大項，其中應力波2D法共檢測樹木有151株(白千層129株、大王椰子22株)，已完成本計畫之預定目視外觀法及非破壞性法檢查樹木的數量及目標。

最嚴重危險等級，建議先進行減輕樹木風險處理。白蟻及腐朽是樹木危害的主要原因，建議進行防治及管理。

The purpose of this project was to investigate the tree hazards assessment of living trees in National Dr. Sun Yat-sen Memorial Hall for providing tree management policy. The project com¬pleted a total of 151 trees (Melaleuca leucadendra and Roy¬stonea regia) in the park and visual shortcomings of the seven major tree structures by visual tree assessment (VTA). A total of 151 trees were detected by 2D stress wave nondestructive technique (NDT). The plan has been completed to check for the trees' objectives by VTA and NDT. For the most serious risk level, it is recommended to reduce the risk with tree treatment. Termites and decay are the main causes of tree damage, preven-tion and management is recommended.



(a) (b) (c) (d)

應用非破壞性技術檢測樹木內部腐朽空洞。(a)應力波2D檢測、(b)鑽孔阻抗法及(c)橫向打擊共振法。

The detection and assessment of decay and cave in living tree by nondestructive techniques. (a) tree detection by stress wave 2D technique, (b) tree detection by drilling resistance technique, and (c) tree detection by lateral impact vibration method.

下坪自然教育園區樹木危險性風險之檢查及評估

林柏亨、林振榮

本計畫目的在對下坪自然教育園區樹木，應用目視樹木檢查法及非破壞性技術，檢測及評估樹木的結構安全性，以提供臺大實驗林管理單位作為樹木管理的參考依據。研究得知樹木檢查首先採取目視法檢查樹木外觀結構性，後續因樹木結構性問題採取不同的非破壞技術，檢測樹木內部的解剖構造，以診斷樹木的結構安全性。不同的樹種有不同的結構性特性及材質，應建立不同樹種的健全標準參考值，以做為劣化程度的比較。不同的結構性問題，應使用不同的非破壞性技術，以檢測樹木不同的結構性缺點及劣化現況，如必要時結合不同的非破壞性技術，以瞭解整體樹木的外部及內部狀況。

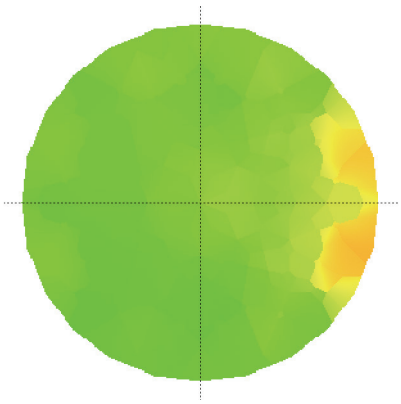
Assessment of standard values (reference) in sound trees by different nondestructive techniques for tree hazard assessment

Item	Methods	Evaluated parameter
1	Visual tree inspection	Tree inspection form
2	Acoustic device 2D tomogram	Transversal acoustic velocity (m/sec)
3	Lateral impact vibration	Diameter × Frequency (m·Hz)
4	Increment borer	Visual observation of core
5	Fractometer	Crushing strength (green, MPa)
6	X-ray wood density profile	Density (air dried, g/cm^3)

Inspection and Assessment of Tree Hazardous Risks in Xiaping Nature Education Area

Po-Hun Lin, Cheng-Jung Lin

The purpose of this project was to investigate the tree hazards assessment of living trees in Xiaping Nature Education Area to provide tree management guidelines. The results that can be used visually inspect living trees according to condition and inspection purposes, to assess the health of the trees and the risk of the appearance of indicators by visual tree assessment. Using different nondestructive techniques such as lateral impact vibration method, stress wave velocity 2D tomography, drilling resistance method, increment borer sampling, fractometer method, X-ray ring density profile etc. and evaluation index, to establish and improve standard reference values of the living trees for checking the internal material conditions of trees. Different nondestructive evaluated parameters could serve as the index of the diagnosis value. A table of standard values for the future use of these nondestructive methods for testing trees with and without decay-damage is presented. The proposed method can be combined with visual tree inspection and other non-destructive techniques to better examine and confirm the situations of trees for tree risk assessment.



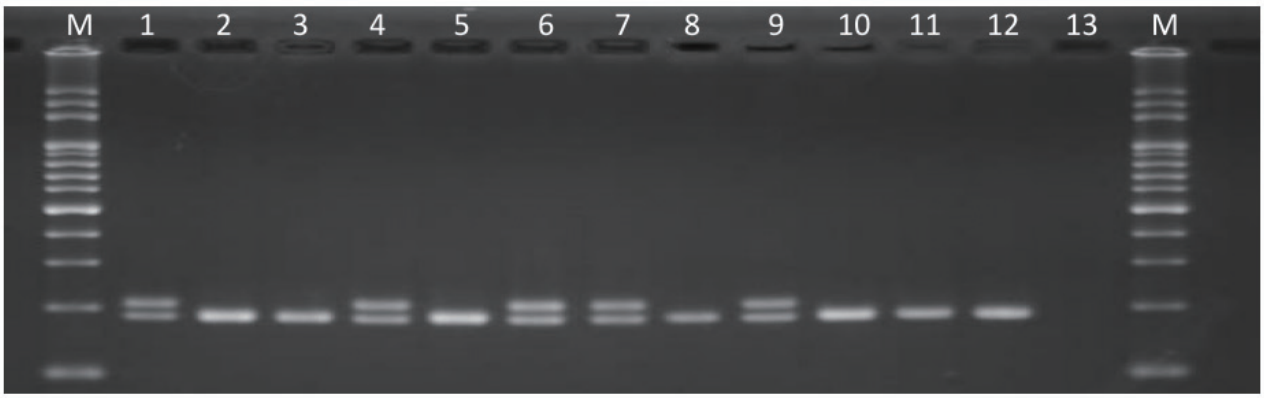
		1794	1790	1780	1770	1721		
	1875	1819	1783	1843	1800	1723	1747	
	1844	1861	1817	1826	1796	1719	1568	1409
1817	1847	1868	1812	1756	1735	1694	1541	1328
1886	1901	1888	1818	1755	1694	1691	1568	1429
1812	1895	1928	1876	1815	1770	1677	1496	1283
	1899	1951	1922	1928	1867	1731	1534	1357
	1976	1930	1914	1962	1894	1789	1796	
		1912	1914	1914	1886	1821		

Stress wave velocity tomogram and the corresponding stress wave velocity map grids (3×3cm) of a damaged tree (no.CF27-1, velocity range, 734-2095 m/sec).

泡桐抗簇葉病基因相關微衛星分子標誌之研發

何政坤、陳怡蒨、張淑華

臺灣泡桐是白桐×泡桐的雜交種，在1977年曾以黃金樹聞名於臺灣。當時曾栽培到進2萬公頃，但因擬菌質體引起的致死性簇葉病，而摧毀了泡桐木材產業。從那時起，選育抗病泡桐的努力就從為間斷。最近因擬菌質體的接種與偵測技術的成功，加上利用花穗嫁接砧木的控制授粉的改善，可以診斷易罹病臺灣泡桐與引進中國的抗病泡桐。臺灣原生臺灣泡桐及白桐與抗病泡桐雜交種經感染含有擬菌質體，也呈現抗簇葉病能力。這些雜交種造林到疫區8.5年生長快速，也未呈現病症。此結果激勵我們利用SSR技術找出抗病分子標誌。2014年10月以人工授粉獲得白桐、臺灣泡桐、貴州泡桐、及白桐×貴州泡桐的雜交種子，經種子重量與發芽率調查，泡桐種間結果率及每果實種子數以海拔400m的信賢苗圃比海拔6m的臺北苗圃較高，雜交種子發芽率在60-90%間。當相同母本與不同父本雜交時，雜交種子重量受父系影響較大。2014年因貴州與雜交泡桐花穗嫁接成功率極低，2015年以此二種為主進行嫁接授粉，貴州泡桐較去年提早一個月嫁接，獲得成功開花率與座果率。採自海拔2,000m母樹的白桐，開花成功率低，此結果與2014年在臺北苗圃的試驗結果相同，都因初春溫度劇烈變化所致。本年度參考已發表的文獻及線上基因庫中泡桐屬相關的基因序列，設計了50組SSR引子，可合成PCR產物的引子比例為82%，其中在初步測試即已可見多型性的引子有10組(圖1)，可使用篩選出的引子針對控制授粉雜交所得的泡桐苗木進行SSR分子標誌分析。



母本雜交泡桐母樹(*P. kawakamii*×*P. fortunei* = Pk x Pf =Kf)×父本泡桐(*P. fortunei* = Pf)後裔苗10株之引子(PT 12FR)檢定之電泳膠體，後裔苗泡桐(Pf)與雜交泡桐(Kf)比例 = 3:2。圖中符號：M = 1kg DNA ladder, 1 = 母本Kf，2-11=雜交苗，12 = 父本Pf。

A gel of DNA electrophoresis pattern of 10 offspring derived from maternal plant of (*P. kawakamii*×*P. fortunei* = Pk×Pf =Kf) crossed with paternal plant (*P. fortunei* = Pf), where DNA fragments were amplified using specific SSR primer (PT 12FR). The ratio of DNA fragments derived from Pf to Pk was 3:2. In the gel, M = 1kg DNA ladder, No.1 = Kf, No.2-11 = offspring, and No.12=Pf.

Study on Selective Breeding of Paulownia Hybrids Resistant to Witches' Broom Disease and Their Relative Molecular Markers

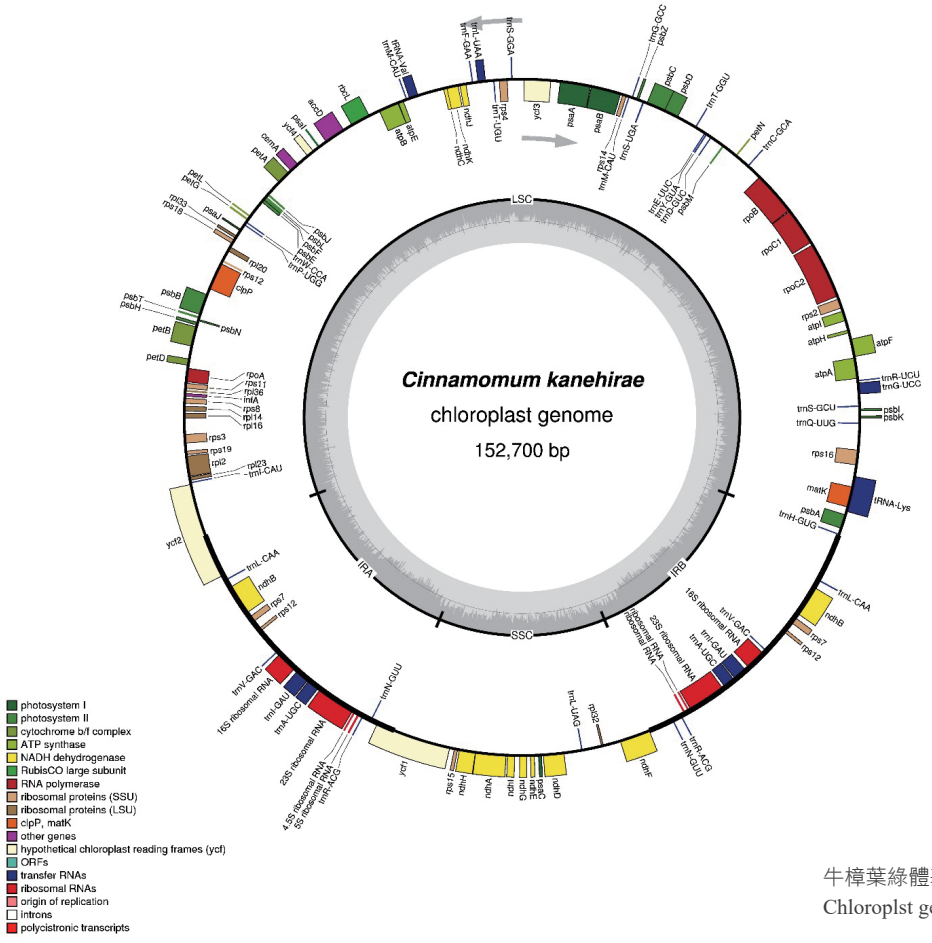
Cheng-Kuen Ho, Yi-Chiann Chen, Shu-Hwa Chang

Paulownia×*taiwanian*, a hybrid of *P. kawakamii* x *P. fortunei* in Taiwan, is famous as a "golden tree" in 1977. At that time, nearly 20,000ha was planted. However, witches' broom disease, a fatal disease caused by phytoplasma, destroyed the wood industry. Since then many efforts on selection and breeding disease resistant varieties of this trees have carried out. Recently the techs of infection and detection of phytoplasma coupling with the improvement of control pollination by grafting flower spikes onto stocks were established. Diagnosis of susceptible *P.* x *taiwaniana* and resistant *P. fortunei* introduced from China were proven. The hybrids between *P.* x *taiwaniana*/ *P. kawakamii* cross with *P. fortunei* showed resistant to witches' broom disease, when they were infected with phytoplasma. They grew fast and showed not symptom of witches' broom disease after been planted for 8.5 years in infection area. This fact has excited us to find out putative DNA molecular marker linked with witches' broom disease resistant gene. In October 2014, seeds were obtained by using control pollination between *Paulownia kawakamii* (coded as K), *P.Ítaiwaniana* (coded as T), *P. fortunei* (introduced from Guizhou, China, coded as G), and hybrids of K×G (coded as Kg) in Feb. According to seed qualities including seeds per fruit, seed weight, and seed germination rate, pollination at Shinshiang nursery (400m in elevation) was better than at Taipei nursery (6m in elevation). Seed germination rates of hybrids ranged between 60% and 90%, indicating that hybridization barrier do not exist between *Paulownia* species. We found that seed weight of hybrids was related to paternal trees when it had the same maternal tree. Due to failure of grafting spikes of G and Kg in 2014, we grafted on January earlier one month in this year. Successful flowering rates and fruit setting were obtained. However, *P. kawakamii* flowers that collected from trees grown at 2,000m in elevation failed for dramatic climate changes in spring this year, similar the result tested at Taipei nursery in 2014. We designed 50 primer sets of SSR according to the published research paper and gene bank on web. Out of them, 82% products of PCR were obtained. In the primary test, 10 primer sets could produce polymorphism of DNA fragments (Fig.1), which will be used to be a genetic markers to identify the genetic relationship of hybrid seedlings.

運用生化與分子標誌於牛樟天然與育種族群以建立健康營養系林業與種子生產

張淑華、何政坤、吳家禎

牛樟為臺灣特有種，因可生產昂貴的牛樟芝，木材價值也跟著高昂。培育高發根率扦插苗及來自少數母樹生產的種子苗，將使得未來純系造林風險提高。同時我們發現牛樟與樟樹有雜交苗，已用DNA標誌檢定出來，這些雜交種的樟腦與芳樟醇的濃度較牛樟高。經我們調查牛樟的葉、枝、與木材發現牛樟的4-松油醇、芝麻素、7羥基芝麻素濃度特別高，可以當作牛樟與其他樟屬樹種區隔，同時也可當作種間變異的研究，是頗佳的生化標誌。最近簡單重複序列標誌的研究極被重視，因此標誌位於基因組的轉錄區且有潛力連接到關鍵表型的基因座，有利於作為輔助育種標誌。牛樟早期被認為右樟，中國分類學者將牛樟視為右樟，而被國際採用。利用葉綠體基因組全解序，以及葉片芳樟醇、芝麻素、與4羥基芝麻素化學成分標誌，可確認二者差異頗大。牛樟葉綠體全基因組序列完成解序，全基因組為152,700bp，呈現典型環狀構造，包括1對20,107bp的插入重複組(IRa/b)，該序列組被一具有93,642bp大單拷貝區(LSC)與具有18,844bp的小單拷貝區(SSC)所分隔，基因組的GC含量為39.1% (圖1)。右樟葉綠體全基因組為152,675bp，略少於牛樟25bp，有19個簡單重複序列(SSRs)與72個插入缺失(InDels)不同於牛樟，可做為分子標誌鑑別。牛樟葉片化學成分具有芳樟醇(linalool)與芝麻素(sesamin)，而右樟無，可作為化學成分標誌。



牛樟葉綠體基因組
Chloroplst geome of *Cinnamomum kanehirae*.

Biochemical and Molecular Markers Used in Natural and Breeding Population of *Cinnamomum kanehirae* for Healthy Clonal Forestry and Seed Production

Shu-Hwa Chang, Cheng-Kuen Ho, Chia-Chen Wu

Cinnamomum kanehirae, an endemic tree species in Taiwan, is valuable for its logs growing *Antrodia cinnamomea* fungal fruiting bodies, a high value pharmaceutical herb. A great risk is occurring in future plantation that they have a great possibility of came from few clones with high rooting ability, and inbreeding seedlings from few parents. The hybrids between *C. kanehirae* and *C. camphora* were found and proven by DNA markers by our lab. We found that hybrids contained high level of camphor and linalool. Investigating essential oils and lignans in leaves, twigs and woods of *C. kanehirae*, we found 4-terpineol, sesamin, and 7-hydroxy sesamin are special high in this species. Those chemicals could be good indices of biochemical markers to distinguish it from other species and might show a great variation between clones. Recently genic-SSR, targeting the transcribed region of the genome and potentially linking to loci with key phenotypes, has been addressed. *C. kanahirae* was identified as the synoym species of *C. microanthum* by taxonomist of China, this view was accepted by the world. Using complete chloroplast genome and chemical components of leaves between both species, we confirmed that *C. kanehirae* is quite different from *C. microanthum*. The complete chloroplast genome of *C. kanehirae* was revealed. The total genome size is152,700bp, with a typical circular structure including a pair of inverted repeats (IRa/b) of 20,107bp of length separated by a large single-copy region (LSC) and a small single-copy region (SSC) of 93,642bp and 18,844bp of length, respectively. The overall GC content of the genome is 39.1%. The total length of the *C. micranthum* cp genome is 152,675bp, which is 25bp shorter than that of *C. kanehirae*. A total of 19 simple sequence repeats (SSRs) and 72 insertions and deletions (InDels) were identified between the two species. Six validated InDels can be used to practically distinguish between two species. The chemical analyses revealed high levels of linalool and sesamin were present in *C. kanehirae* but not in *C. micranthum*.

2015國際土壤年－誰在地下呼吸

2015 International Year of the Soil - Below Ground Respiration

王巧萍

Chiao-Ping Wang

為提高人類社會對全球土壤持續劣化的意識，以避免土壤退化所帶來各項災難，第68次聯合國大會於2013年12月宣布將2015年定為「國際土壤年」。本計畫希望藉由課程活動的執行，讓學子們對土壤科學與生態學產生興趣，進而養成環境觀察與科學思考的習慣，希望可因此提高學生的科學素養，並激發對土壤資源保育的重視。計畫中採取以下兩種實施方式：(一)辦理中小學校土壤科學教育推廣活動。(二)利用臉書社群網站的粉絲頁持續推廣土壤科學相關資訊。成果總計辦理15梯次的「誰在地下呼吸」課程活動，共有684名學生及37名教師參與；粉絲頁在計畫執行期間，按讚人數共有2,168人，最高觸及人數30,072人。未來預計以本年度活動辦理的經驗為基礎，持續進行一系列的課程規劃及發展。

In order to improve the awareness of the deterioration of the global soil, to avoid the catastrophes caused by soil degradation, the 68th United Nations General Assembly announced in December 2013 that it will designate the year 2015 designated as “International Year of the Soil.” The program hoped that by the implementation of the curriculum activities, the students can find the interest in soil science and ecology, and develop the habit of environmental observation and scientific thinking. Hoping to improve the scientific literacy of students and stimulate the attention to conservation of soil resources. The plan took the following two ways: (1) for primary and secondary schools to promote soil science education activities; (2) the use of Facebook page of the fan site to continue promoting soil science related information. A total of 684 students and 37 teachers participated in the course of “Who’re breathing underground?” There were 2,168 visitors during the implementation of the program, with a maximum of 30,072 people learning our program. The future is expected to be based on the experience of this year’s activities, based on a series of curriculum planning and development.

講師教導學生如何測試土壤物理質地。
The instructor teaches the students how to test the soil physical texture.

學生親自挑出各自所設陷阱所捕獲的土壤無脊椎動物樣本。
The students pick up the soil invertebrates samples from their own pit fall traps.

以參與式公民科學建立傳統生態智慧的民族植物園

Establish Ethnobotanical Gardens with Traditional Ecological Knowledge by Participatory Citizen Science

董景生

Gene-Sheng Tung

本計畫欲收集原住民區域的傳統生態知識(traditional ecological knowledge, TEK)，結合部落的民族植物產業，以植物園進行展示教育，讓參訪者認知植物和生活的關聯性，串連原住民傳統保育知識與現代生活。選定南投信義鄉布農族的望鄉為重點研究部落，針對女性農耕及男性山林狩獵文化進行調查，記錄相關的民族植物TEK，並整理歷史文獻。期間保存並記錄部落傳統作物，包含豆類、穀類、蔬菜、根莖類作物共30種，並記錄相關栽培方式及耕作曆。訪談男性獵人，記錄傳統陷阱種類及製作方式，山林狩獵TEK，包括製作陷阱、獵具、火藥、薪柴、器具、食物、藥、狩獵等植物，共計36種。後續預計以獵人古道為山林狩獵文化的展示步道；婦女的農耕作物則展示於部落選出的公有地。本計畫將篩選出具文化代表的植物，結合參與式繪圖、公眾參與地理資訊系統(public participation GIS, PPGIS)技術，標定步道與農田的解說用民族植物，及相對應的微環境。整合部落公民知識，製作解說牌、自導式解說摺頁、及合乎在地環境生活的種植曆，同時協助部落培育具經濟產能的植物，與結合民族智慧的產製品。

This project aims to collect the Traditional Ecological Knowledge (TEK) of the indigenous areas, combine the ethnobotany industry of the tribe, and display them at the botanical garden so that the public can better understand the relevance of the plant and life, establish the connection between TEK and modern life. This ongoing project focuses on the study of the female farming and male hunting culture of Wang-hsiang Bunun tribe in Nantou County. The ethnobotanical knowledge and TEK were recorded, and the relevant historical literatures were gathered. So far, 30 kinds of traditional crops such as legumes, grains, wild vegetables and rhizomes related to cultivation methods and cultivation calendar were recorded for the women's wisdom related to traditional crop types. A total of 36 kinds of male forest hunting-related plant resources, such as the production of traps and hunting gears, gunpowder, firewood, food, equipment, medicinal and hunting bait plants were recorded as well. The subsequent plan is expected to use the local hunting trail to display the traditional hunting culture, and the ethnic farming crops are displayed in the public fields chosen by the tribe or planted in the public space of the household. The public participatory methods such as screening out the representative ethnic plants with local people, participatory drawing, Public Participation GIS (PPGIS) involved in the citizen science will be used in this project, and the ethnic plants on the trail, farmland, or the corresponding microenvironment will be labeled. The goal of this project is to produce information boards and self-guided brochures of local in-depth travel by means of democratic knowledge, and to help local people to cultivate the potential economic plants which can produce the products combined with the depth of ethnic culture as well.

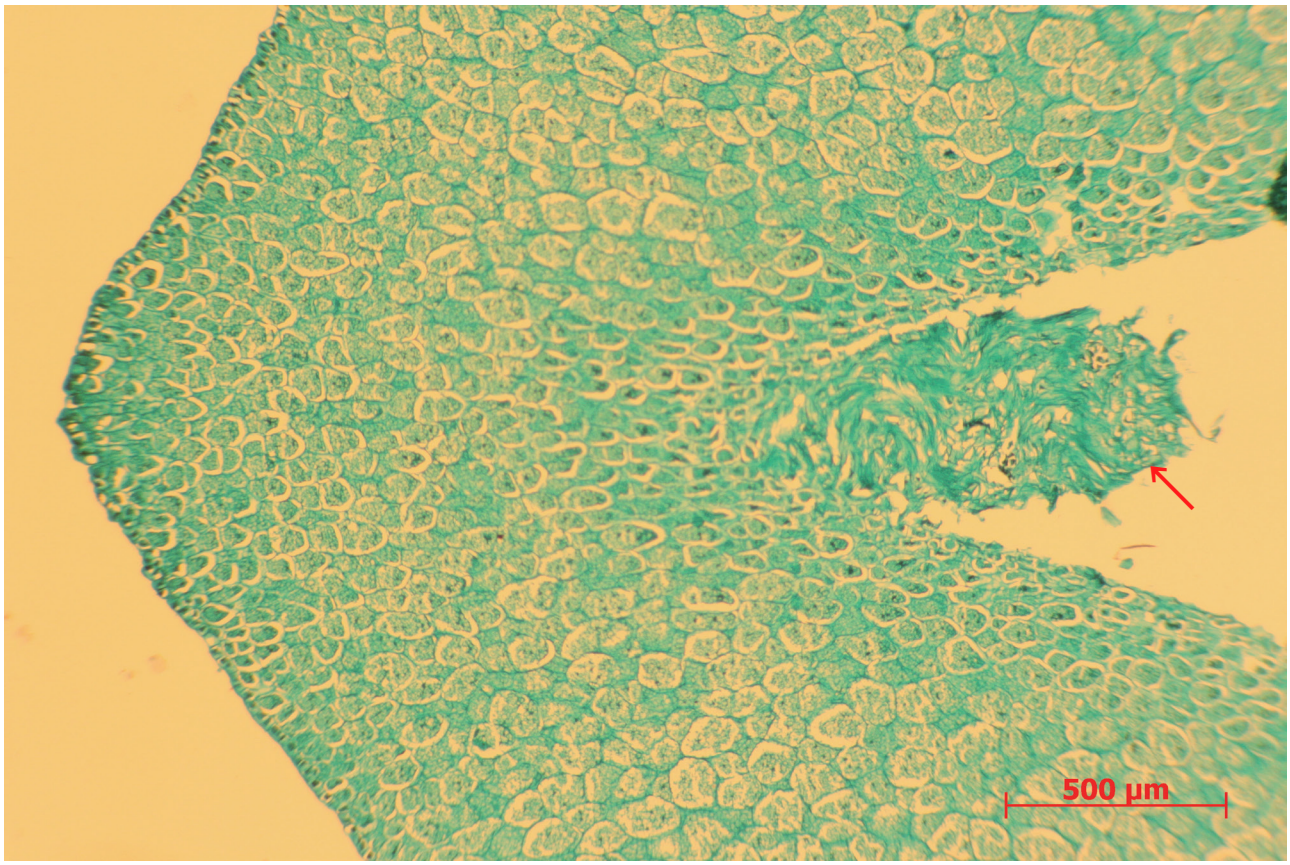
在望鄉部落，以參與式公民科學法訪談布農耆老收集傳統生態智慧。

The project applied the citizen scientific method to interview elders for collecting the traditional ecological wisdom in Wang-hsiang village.

臺灣穗花杉胚胎發育與種子休眠性之研究

鍾振德

臺灣穗花杉僅分布於臺灣本島南端，由於族群稀少，被列為積極保育之本土樹種。臺灣穗花杉由於族群稀少有性生殖能力薄弱，使得種子產生不易。過去兩年研究已完成誘導花芽分化，以及完成生殖系統胚胎發育之解剖觀察。利用枝條環狀剝皮處理，環狀剝皮1.0cm寬，誘導100%臺灣穗花杉花芽分化。另外對29株盆缽植株，進行有性生殖觀察，包括花粉與胚珠發育、授粉、授精以及胚胎之發育。雄毬在3月中旬結束休眠，小孢子形成於3月底漸漸發育成熟。成熟花粉大小約25μm。雌毬在3月底結束休眠，胚珠裸露後不久即分泌授粉滴。約在4月初開始授粉，授粉期約1~2星期。大孢子於3月底開始逐漸發育，此時雌配子體尚未成熟，直到6月初成熟時才完成授精。當種子成熟掉落時，胚還未發育完成，而且發現同時間人工授粉，但種子的成熟時間卻從授粉後隔年的4月一直到12月，胚未成熟發育應該是主因。臺灣穗花杉種子深度休眠，需經暖低溫層積處理後發芽，因此後續將聚焦種子生理與胚休眠之研究，探討解除胚休眠的過程中，激勃素、細胞分裂素、離層酸與IAA等等荷爾蒙之代謝變化。計畫目標研究臺灣穗花杉生殖生物學之知識，解決臺灣穗花杉生殖之困境，增加飽滿種子之生產。



a. 種子成熟掉落時，胚(箭頭處)尚未分化成熟。
Embryos are not well developed when the seed mature and shed.

Study of Embryo Development and Seed Dormancy in *Amentotaxus formosana*

Jeng-Der Chung

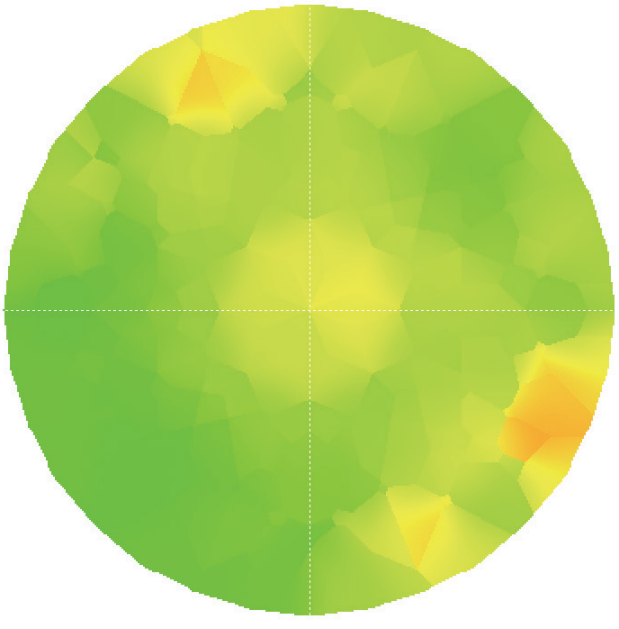
Amentotaxus formosana, an indigenous tree, is native only in the southern areas of Taiwan. It is listed as a protected species by the Taiwan government due to the scarcity of populations and low seed production. For the last two years we have been working to achieve the goal of enhancing flowering bud initiation and accomplishing the anatomical survey of reproductive system of *A. formosana*. By using a girdling device to remove a 1.0cm wide ring, the flower bud differentiation was consistent, with all container-grown cultivars achieving 100% induction. Furthermore, the survey of reproductive system counted approximately 128 individuals including pollen and ovule development, pollination, fertilization as well as embryo development. Pollen cones ended dormancy in middle-March, microsporogenesis occurred in late March. Mature dry pollen was about 25μm in diameter. The seed cones ended dormancy at the end of March, opened to expose the ovules, and soon after secreted pollination drops. Pollination occurred for about 1-2 week in early April. Megasporogenesis occurred in late March but female gametophytes did not mature and fertilization did not occur until early June. Embryos are not well developed when the seed mature and shed. Thus, we found that the timing of seed maturity is probably from March to August of next year, even at the same time by hand-pollination. *A. formosana* seeds have deep dormancy. Warm stratification followed by cold stratification and then warm-temperature incubation are required for germination to occur. Therefore, the following topic is dedicated to doing a research on seed physiology and embryo dormancy. Understanding the metabolic changes in phytohormones (including GAs, cytokinin, ABA, IAA etc.) of breaking embryo dormancy is one of the goals of this project. To sum up, the goal of this study is to provide methods to increase cone and filled seed production.

b. 臺灣穗花杉發芽種子栽植於寬7.5cm軟缽7-9個月。
Seedlings of *A. formosana* were grown in plastic pots (7.5cm diameter) for 7 to 9 months.

中海拔人工林更新及環境與樹木生長及健康性關係之研究

林柏亨、林振榮

本計畫目的在探究中海拔溪頭實驗林生態系經營環境與樹木健康關係之研究，以提供樹木管理政策之參考，本計畫從樹木外觀檢查及內部木質部的檢測作為樹木健康性的評估指標。結果得知可使用目視法檢查柳杉、臺灣杉及紅檜樹木外觀，依據樹木狀況及檢查目的，來評估樹木健康性的外觀指標。檢查樹木內部木質部狀況，採用不同的非破壞性技術，例如橫向打擊共振法、應力波斷面影像法、鑽孔抵抗法、樹芯取樣法、微破壞儀法、樹輪密度圖譜法的評估指標，建立健全樹木標準參考值，來檢查樹木的內部材質狀況。可使用應力波斷面影像法檢查腐朽受損的柳杉樹木，以橫向音速大小來評估樹幹橫斷面的劣化狀況。最後結合目視檢查及不同非破壞性技術檢測及評估樹木的結構性及健康性。初步結果得知中海拔森林的經營強度、頻率、人為干擾與樹木的生長及健康性有關，為了營造良好的樹木健康性，需建立森林經營的目的及目標，採行樹木管理措施使維護樹木的健康性，以發揮樹木公益功能，具體的樹木健康生長反應，待最後1年繼續整合及收集資料完成。



			1740	1781	1818			
	1866	1774	1762	1827	1818	1866	1897	
	1860	1832	1826	1823	1838	1908	1897	
1904	1937	1881	1819	1773	1791	1847	1864	1837
2021	1904	1897	1805	1819	1768	1791	1848	1864
2006	2002	1933	1850	1812	1831	1830	1778	1715
	2037	2026	1927	1891	1862	1801	1733	
	2049	2019	1958	1925	1814	1766	1823	
			1982	1917	1832			

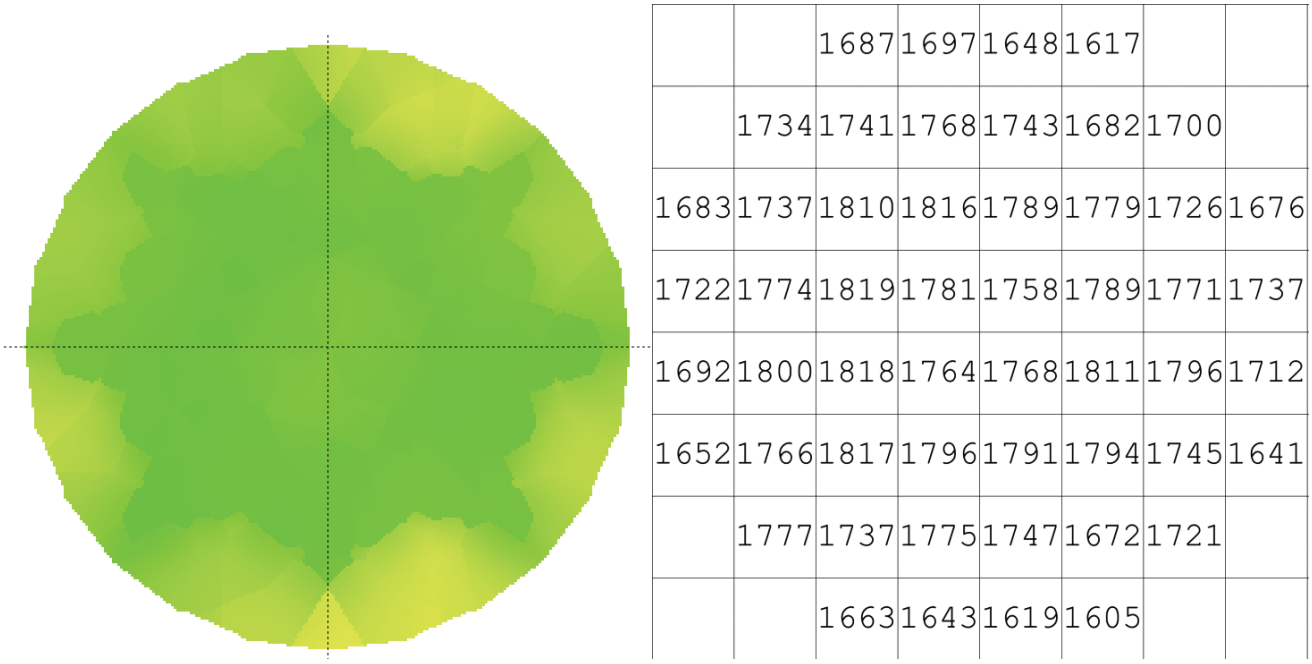
圖1 健全臺灣杉(No.56)立木的橫向應力波2D影像及音速圖譜(案例)。

Fig. 1 The 2D image and acoustic velocity profile of *Taiwania cryptomerioides* living tree (No.56).

Relationship Between the Plantation Ecology Management and Tree Health in Medium Elevation Area

Po-Hung Lin, Cheng-Jung Lin

The purpose of this project was to explore the relationship between an ecologically sustainably managed plantation and tree health in Xitou Nature Education Area for tree management policy reference. The results suggest that visually inspection of Japanese cedar, Taiwania, and red cypress trees according to conditions and inspection purposes, to assess the health of the trees and the risk of the appearance of indicators. Using different nondestructive techniques such as lateral impact vibration method, stress wave velocity 2D tomography, drilling resistance method, increment borer sampling, fractometer method, X-ray ring density profile etc. and evaluation index to establish and improve standard reference values of Japanese cedar, Taiwania, and red cypress trees for checking the internal material conditions of the trees. Different nondestructive evaluated parameters could serve as the index of diagnosis value. A table of standard values for future use of these nondestructive methods of testing Japanese cedar, Taiwania, and red cypress trees with and without decay-damage is presented. The V tomogram and corresponding stress wave velocity maps of decay-damaged and undamaged Japanese cedar, Taiwania, and red cypress trees can detect the general location and area of wood deterioration. The proposed method can be combined with visual tree inspection and other non-destructive techniques to better examine and confirm the situations of trees for tree health assessment. Preliminary results show that the tree health was affected by forest management intensity and frequency, and human disturbance factors. To foster better tree health, we propose that forest management objectives and targets should be clearly defined so that both tree health and public function of forest can be attained.



		1687	1697	1648	1617		
	1734	1741	1768	1743	1682	1700	
1683	1737	1810	1816	1789	1779	1726	1676
1722	1774	1819	1781	1758	1789	1771	1737
1692	1800	1818	1764	1768	1811	1796	1712
1652	1766	1817	1796	1791	1794	1745	1641
	1777	1737	1775	1747	1672	1721	
		1663	1643	1619	1605		

圖2 健全紅檜(No.82)立木的橫向應力波2D影像及音速圖譜(案例)。

Fig. 2 The 2D image and acoustic velocity profile of *Chamaecyparis formosensis* living tree (No.82).

友善環境之木竹材採運機械與作業道規劃技術研究

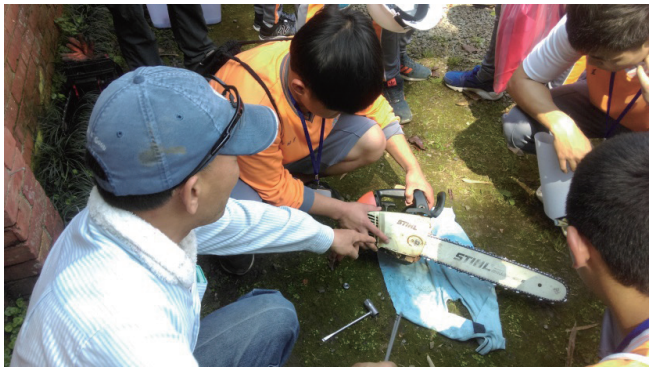
Study on Application of Environmental Friendly Timber Harvesting Machines and Planning Technology of Operational Road

林裕仁

Yu-Jen Lin

本計畫目的在借鏡國外森林作業機械化經驗與林業人才培訓機制，推動環境友善之木材採運技術與作業道路網規劃交流，提昇國內木竹材收獲作業效率與原木生產作業人才技術訓練，藉以提高臺灣國內自產材比率，振興臺灣林業。依據計畫預定內容所執行重要成果計有：1.完成邀請日本林業專家來臺舉辦技術演講2場與實務講習活動1場；2.完成前往歐盟(芬蘭)參訪林木生產機械採運技術行程1趟次；3.完成前往日本參訪林木機械採運技術與人才培訓制度行程2趟次；4.於苗栗縣南庄鄉完成「2016林木採集技術訓練講習」之舉辦1場；5.完成「森林作業道施作基本原則」之草擬等多項工作，均按照計畫期程順利執行，達成預期目標，研究之豐碩成果可提供林業主管機關作為政策擬訂之參考。

The purposes of this project are to increase production of domestic logs and to revitalize forest industry in Taiwan by training forest operators to learn from foreign successful experiences in the fields of forest operation mechanizing and their training mechanism, promoting international exchanges on environmental friendly technologies of log harvesting and networks planning of forest operational paths, enhancing domestic log harvesting efficiency and strengthening technical training of log production to forest operators. According to the initial project contents, this project has performed the following: 1) invited Japanese forest experts to Taiwan and gave 2 lectures and offered 1 workshop on professional technologies and practices; 2) fulfilled one visit plan on mechanical harvest technologies of logs production to Finland; 3) visited twice the training mechanism of forest operators and mechanical harvest technologies of log production in Japan ; 4) held a training course on logging operation with small machineries for young forest students in Nanzhuang Township, Miaoli County; 5) drew up a draft on “basic principles on forest operational path construction.” All these works were smoothly implemented based on the project processes and reached expected results. These fruitful results can provide some reference to forestry authority for strategy modulation.



2016

Annual Report

參

附錄

Appendix

105年度 1月—12月

1 JAN

- 本所於1月5日假行政院農業委員會召開「經營山林、森入其鏡－林試所技術影片發表記者會」，由黃裕星所長主持，共發表「五色鳥的都市生活小秘密」、「山地混農林業之永續經營」、「竹峰、竹語」、「關心樹木健康，大家一起來！」等4部科普短片，提供民眾在關心林業發展之餘，也能從生活中落實生態保育的行動。
- 本所於1月21日在總所舉辦「第三屆ISA國際樹藝學會樹藝師授證暨樹藝學研習班結業授證典禮」，由黃裕星所長主持。會中頒發40名新科樹藝師證書，包括英文考試及格者3人，以及通過首次中文考試的37人。同時頒授樹藝學研習班49位學員結業證書，為臺灣建立樹藝師制度和推廣樹醫教育再跨出一大步。
- 技術服務組於1月27日至2月1日舉辦「104年度試驗林示範經營計畫期末業務考察及106年度預定案審查」，由黃裕星所長率領試驗林經營小組委員前往蓮華池、六龜、太麻里及福山等研究中心視察。
- 本所與國立臺灣大學園藝暨景觀學系、臺灣園藝福祉推廣協會以及中華民國人與植物學會，於1月30日在本所舉辦「2016臺日園林療癒暨環境福祉研討會」。會中邀請到前東京農業大學校長暨日本園芸福祉普及協會會長進士五十八先生、日本園芸福祉士暨一級建築士角銅久美子女士及木村洋子女士等人與國內學者專家共聚一堂，分別從日本與臺灣的經驗出發，分享園林療癒對於現代人與自然景觀的重要性。

2 FEB

- 日本東京大學酒井秀夫教授、島根縣素材流通協同組合篠原憲理事長，以及鹿兒島縣素材生產業協同組合連合會神園公博事務局長等3位專家，於2月22日至本所拜會，並分別以「日本之陡坡地集材架線」、「集材架線實務」與「日本九州地區鹿兒島縣之竹材集運」為題進行演講，由黃裕星所長親自接待，並與80多位出席者共同聆聽日本集材架線之最新技術。
- 本所與社團法人臺灣都市林健康美化協會於2月24日在本所合辦「2016樹木風險評估班」，特別邀請到美國Arbor Global公司總經理凱文艾克特(Kevin K. Eckert)先生，同時也是ISA國際樹藝學會認證的大師級樹藝師及攀樹師親自授課，內容包括：風險管理概述、風險程度評估、標的物評估、倒伏可能性、資料分析及風險分類等，共逾50人參加。
- 彰化縣福興鄉大興國小師生共86人為執行「探訪低海拔的諾亞方舟—蓮華池」計畫，於2月26日至蓮華池研究中心進行全天性的生態探索活動，由該中心4位志工老師負責導覽解說。

3 MAR

- 蓮華池研究中心為使全體員工瞭解森林經營(Forest Management, FM)驗證之目的、規範及流程，分別於3月2日及7日以「瞭解FSC™ FM系統運作及建立符合FSC™標準之經營系統」為題，進行3小時的員工教育訓練。
- 本所為響應植樹節「帶小樹苗去旅行」活動，於3月12日由技術服務組陳燕章組長與梧桐環境整合基金會等單位，分別在臺鐵新竹站，以及高鐵臺中站、新竹站與桃園站等地同步發送臺灣樹蘭、羅漢松、榔榆等15種原生樹苗共5,000株並提供植栽諮詢，遊客踴躍領取並攜往各地種植，有效宣導綠化及環保理念。

- 蓮華池研究中心於3月14日舉辦「第1季志工暨員工生態研習」活動，邀請到臺中市野鳥救傷學會研究員林文隆博士講授溪流生態多樣性與魚類、水生昆蟲之調查方法，參加人員反應熱烈。

4 APR

- 恆春研究中心與林務局屏東林區管理處於4月1日至8月30日，在墾丁國家森林遊樂區的遊客中心合辦「小徑材利用工藝特展」，內容包括本所與國立高雄大學傳統工藝與創意設計系的師生共同研發的27組木材工藝組合作品以及其他文創商品。期間並有森林經營組與林業經濟組提供的3場關於林木修枝、木材合法性、串聯林業經營與綠色消費的專題演講，以及多場由社區主導的DIY課程，獲得極大迴響。
- 本所與國立苗栗高級農工職業學校森林科於4月7日在苗栗縣南庄鄉北獅里之私有林地合辦「2016林木採集技術訓練講習」，邀請到行政院國軍退除役官兵輔導委員會森林保育事業管理處的伐採專家吳春榮先生擔任講師，課程包括「鏈鋸介紹、使用與保養」、「鏈鋸實務操作」、「伐木與造材實務操作」等，學生們對於專業的講習與鏈鋸之初體驗均留下深刻的印象。
- 蓮華池研究中心為申請國際認證系統—森林管理委員會(Forest Stewardship Council, FSC™)之森林管理(Forest Management, FM)驗證，於4月13日至15日接受第三方驗證公司必維國際檢驗集團認證部趙高軍主任稽核員進駐，以辦理驗證作業之預審核。預審核會議由邱祈榮副所長主持，並由許原瑞主任率領各業務主協辦人員到場說明。審核項目包括文件審核、苗圃管理、各種試驗樣區管理、高保育價值物種生育地及監測管理、天然林與人工林調查樣區管理等，同時針對該中心之相鄰單位、利害關係團體等進行訪談，以瞭解森林經營管理作業對於各方之影響。
- 植物園組徐嘉君助理研究員為執行「美國西北太平洋區域之森林健康與生態管理」研究，於4月18日至10月19日赴美國奧勒岡州波特蘭市世界林業中心(World Forestry Center)進行研習。
- 中國大陸著名紙張纖維鑑定專家及中國製漿造紙研究院高級工程師王菊華女士、北京承德貢文化有限公司負責人貢斌先生，以及中國文化遺產研究院紙張實驗室王珊小姐，於4月22日在國內手工紙專家王國財先生陪同下，至本所木材纖維組紙張樣品陳列室參觀，由徐健國助理研究員接待導覽，並介紹本所在手工紙科學及書畫裝裱修復方面的研究成果。
- 本所於4月22日及29日舉辦「產業科技策略規劃理論與實務培訓班」，邀請到臺灣農業科技資源運籌管理學會理事長李宜映博士講授如何強化科研人員之系統性思考，如何熟悉策略規劃工具，以及如何提升科技計畫品質，以便針對「目標客群」提出具有創造力與競爭力的研究計畫。

5 MAY

- 本所於5月3日至6月26日邀請來自花蓮縣的「種子野台」在臺北植物園南門町三二三舉辦「人藏夢・夢藏種・種藏人」特展與3場味覺體驗活動，展出阿美族的傳統作物種子，同時透過影像呈現藏種耆老面對老品種的傳承態度，以及草木灰、煙燻、代代種植採種等人為保種方式與農作環境的變遷；除了提供民眾體驗地方傳統作物與特殊風味外，也藉此機會向種藏人與其所守護的味道致敬。
- 邱祈榮副所長於5月5日率領育林組、森林經營組、集水區經營組及六龜研究中心同仁前往六龜試驗林第13林班視察，以規劃不良木伐除與更新造林作業。預計伐除遭受松

鼠危害的柳杉，同時補植當地的原生樹種例如牛樟、臺灣山茶等，以達到提高林木生產、豐富林下經濟副產物與兼顧森林生態發展之多目標經營。

- 本所與梧桐環境整合基金會於5月6日至6月15日假新竹市政府青少年館合辦「生活中的樹」4D體驗生態展，展出森林利用組、森林化學組、木材纖維組之研究成果。黃裕星所長並於開幕當日將本所出版之「樹木風險評估」一書贈予新竹市林智堅市長，期盼民眾在觀展之餘能進一步瞭解樹木的功能，也歡迎大家踴躍加入樹醫志工的行列。
- 本所於5月27日至8月31日在臺北植物園欽差行臺舉辦「巧木綺光－木器車床工藝暨綺光木照燈具展」，邀請到工藝家趙嘉建先生與呂啟光先生展出創作。而不論是利用車床技術將工廠殘材或風倒木賦予新生命的巧木工藝，或是透過構思將外型不起眼的畸木結合光源製作成具有時尚感的綺光燈藝，再再顯示出創作者對於每一塊木材的疼惜，與木質材料天生麗質的美感。展出期間並舉辦3場DIY活動，獲得民眾好評不斷。
- 六龜研究中心志工為協助森林保護組執行「I-TREE都市林效益的評估與分析計畫」，於5月至10月間每逢週末皆派員赴高雄都會公園參與樹木調查作業，前後共逾80人次，提供志願服務時數545小時，完成建置I-TREE調查資料1,000餘筆，成果豐碩。

6 JUNE

- 福山研究中心於6月6日至7日在該中心舉辦「水生植物池經營管理訓練班」，由黃裕星所長主持開訓儀式。課程包括：水生植物概說、水生植物經營管理、水生池之魚類經營管理及實習、水生植物池之監測與實務、水生池的水文與水質維護管理，以及水生植物池之踏勘與實作等，藉此加強學員們對於森林水文環境的認識與經營水生植物池的實力。
- 技術服務組於6月16日在總所舉辦「翻轉從閱讀開始—第六屆好書交換活動」，展出募得的書刊近1,200餘冊。透過二手書的交流機制，讓好書翻轉重獲新生，也讓知識傳遞再次發光。現場同時展出本所研發成功的防蚊用品等技轉成果，宛如一場智慧財產的嘉年華會，共逾70人參加。
- 本所於6月16日至17日假蓮華池研究中心舉辦「第一次園林療癒基地推動小組工作會議」，由黃裕星所長主持，共邀集所內園藝景觀、植物精油、芬多精、動物資源體驗、木工創作等領域專家21人參與。會中除確認蓮華池研究中心作為森林療癒基地值得進一步開發的主題與方法外，亦完成基地的動線勘查與初步規劃景點。

7 JULY

- 蓮華池研究中心為申請國際認證系統—森林管理委員會(Forest Stewardship Council, FSC™)之森林管理(Forest Management, FM)驗證，於7月4日至6日接受臺灣衛理國際驗證股份有限公司指派稽核員2名進駐，以辦理驗證作業之主審核。審核項目包括：在預審核階段所列舉之應改進事項是否已悉數完成，以及該中心之森林管理作業是否符合FSC™ FM之10項原則與所有指標等。在主審核的總結會議上，2位稽核員僅提出3項可以改善的小缺失，其餘部分未有意見，換言之，該中心之森林管理作業已符合FSC™所揭櫫「森林經營組織應負責任地經營森林」之精神，成功通過FSC™ FM嚴格的驗證標準。這不啻是蓮華池研究中心歷年來全體同仁的努力成果，也是臺灣國有林經營管理的重大里程碑。
- 強烈颱風尼伯特(Typhoon Nepartak)於7月8日狂襲臺東縣，造成境內許多珍貴樹木嚴重受損。本所於7月11日緊急聯繫臺灣都市林健康美化協會，於短短12小時內號召38位志

願專家，包括12位國際認證樹藝師，連同5輛吊車、2輛挖土機及1輛澆水車及司機共45人趕赴當地搶救樹木。本所亦派遣3位國際認證樹藝師同仁前往支援，以期結合官方與民間力量加速救援珍貴樹木。

8 AUG

- 本所「105年度試驗林示範經營計畫期中考察」於8月3日至5日及8日進行，試驗林經營小組委員特別針對：蓮華池研究中心的園林療癒基地規劃，六龜研究中心扇平科學園區之軟體設施改善，恆春研究中心高士佛試驗林地定位為特稀有動植物區外保育重要基地，恆春研究中心的梅花鹿生態監測與防治試驗，以及福山研究中心水生生態池之管理作業等，進行視察並提出改善意見。
- 世界竹會(World Bamboo Organization, WBO)主席Michel Abadie博士在臺灣大學榮譽退休教授吳順昭博士及竹類專家呂錦明博士陪同下，於8月5日拜會本所，由邱祈榮副所長率同育林組陳財輝研究員與森林利用組林裕仁副研究員接待。雙方就竹林資源保育、竹材加工利用與竹文化推廣等議題交換意見，隨後前往臺北植物園參觀，外賓們對於園區提供都市居民優質的休憩空間與豐富的教育功能留下深刻印象。
- 日本水資源環境學會若井郁次郎理事、野村克己理事等人在竹類專家呂錦明博士陪同下，於8月22日拜會本所，由技術服務組陳燕章組長、集水區經營組游漢明組長及育林組陳財輝研究員等人接待。雙方針對臺北植物園之歷史沿革與經營現況、臺灣漁業保安林之發展、森林之水源涵養功能等議題進行交流，之後參觀臺北植物園的特色植物，以及欽差行臺與南門町三二三等中日建築。
- 林業經濟組、森林經營組及中埔研究中心於8月22日至24日，在雲林縣古坑鄉崁腳農場之14年生臺灣櫸造林地，舉辦「人工林修枝撫育護林行動工作坊」，共有來自財團法人慈心有機農業發展基金會、荒野保護協會，以及臺灣大學與嘉義大學的森林系師生共22人參加。

9 SEP

- 監察院張博雅院長與財政及經濟委員會召集人楊美鈴監察委員等10人，在行政院農業委員會翁章梁副主任委員陪同下，於9月1日上午抵達蓮華池研究中心視察，由黃裕星所長率同許原瑞主任等人接待。在聽取簡報之後觀賞該中心動態樣區之野生動物監測影片，並前往轄區之苗圃、天然林、人工林與巨竹園勘察。委員們對於蓮華池研究中心之油茶試驗、森林資源經營、竹類保育，以及生物多樣性之維護與監測等研究成果深表讚許。
- 黃裕星所長於9月13日出席由內政部營建署主辦的「2016國際濕地大會」，並代表本所與內政部營建署、行政院環境保護署、行政院農業委員會林務局、經濟部水利署、行政院農業委員會特有生物研究保育中心等機關共同簽署「2016-2021年濕地保育部會合作協議」，以加強部會間之合作、協調及分享濕地生態系統的科學知識與技術。
- 本所與社團法人臺灣都市林健康美化協會、財團法人梧桐環境整合基金會，自9月23日起至10月2日止假臺北市大安森林公園捷運站合辦「生活中的樹」生態展。藉由淺顯易懂的文字與珍貴的樹木標本，向民眾傳達植樹造林的益處與減緩全球暖化的重要性，現場同時贈送在地種子包，並提供免費的導覽與盆栽健診活動，讓民眾在捷運站內也能享受到另類的「森呼吸」。

10 OCT

- 本所與臺灣植物及樹木醫學學會、臺北市盆景協會於10月5日至9日，在臺北植物園欽差行臺合辦「2016漢風盆景展」。期間除了展示造型優美的盆景外，亦邀請到日本盆景大師漆畑大雅及佐佐木雅裕親臨示範黑松與真柏之盆景製作，不僅促成臺日盆景技術的深化交流，亦引領民眾進入盆景藝術的世界。
- 日本宮崎縣環境森林部大坪篤史部長等7人及臺灣科技大學吳惠萍教授等6人，於10月11日下午至本所拜會，由邱祈榮副所長率同技術服務組陳燕章組長、育林組陳財輝研究員等人接待，除了針對臺灣林業發展之現況及未來規劃、臺灣木材及林產品進出口情況、臺灣木材製材與加工技術、採伐資訊與技術支援、日本之森林資源與伐採利用等議題進行交流外，並向外賓導覽臺北植物園南門町323之建築造景與經營模式。

11 NOV

- 本所於11月5日在總所舉辦「臺北植物園120週年紀念國際研討會」，由行政院農業委員會曹啟鴻主任委員親臨致詞並揭開序幕。本次研討會以「植物園的歷史與未來展望」為主題，同時強調植物學與歷史、社會、文化及環境的緊密關係。會中特別邀請與臺北植物園同屬於植物園保育聯盟的東亞國家共襄盛舉，包括：日本小石川植物園、新加坡植物園、南韓國家樹木園均派員出席並提供演講，場面盛大，共計240人參加。
- 黃裕星所長於11月5日代表本所與交通部中央氣象局簽署「生態監測與生物氣候觀測作業技術合作」備忘錄。雙方同意未來在互惠原則下，分享氣象監測預報、生態監測，以及與生物氣候觀測相關之資訊、技術與研究資源，以促進在生態監測、生物氣候觀測，以及生態環境應用上的合作研究。
- 蓮華池研究中心為申請國際認證系統—森林管理委員會(Forest Stewardship Council, FSC™)之森林管理(Forest Management, FM)驗證，繼完成預審核、主審核等程序後，終於取得臺灣地區國有林第一張FSC™森林管理系統驗證合格證書。許原瑞主任於11月8日代表該中心至總所「林業試驗所蓮華池研究中心FSC™森林管理驗證合格證書授證儀式暨國有林森林認證研討會」正式受領證書。頒授儀式由黃裕星所長主持，會中邀請到臺灣衛理國際品保驗證股份有限公司大中華區市場及銷售譚秋朗副總裁頒發證書，並有行政院農業委員會曹啟鴻主任委員、考試院王亞男考試委員、林務局林華慶局長、臺灣森林認證發展協會劉炯錫理事長等113位貴賓觀禮，典禮圓滿順利。
- 本所與中華林學會於11月12日在總所舉辦「2016林業研究人員增能工作坊」，由黃裕星所長主持，參加人員包括本所的研究人力與各大學林業相關科系的研究生，課程涵蓋：「林業研究新典範：資訊學之應用」、「系統性研究思考」、「林業研究試驗設計與分析」、「林業研究論文寫作秘訣」、「林業研究趨勢與定位」等，以期提升參訓者之科研能力。
- 本所與中華花藝文教基金會、梧桐環境整合基金會於11月18日至27日在臺北植物園南門町三二三舉辦「花現323植物園驚嘆號」花藝展，利用園內植物為素材創作花藝作品，以引領民眾從不同角度觀賞植物。展出主題包括：將食材轉為花材的「以食為天」；呈現水草美麗樣貌的「在水一方」；以蕨類植物營造清新脫俗的「蕨代風華」等。不論是花藝設計或空間布置，參訪嘉賓均讚賞不已。
- 技術服務組於11月22日在總所舉辦「105年簡易評價表說明會暨種子培訓課程」，邀

請到財團法人農業科技研究院的講師針對技術價值評估法及簡易評價表之使用深入說明，以提升研究人員自行評價研發成果的能力，共有52人參訓。

12 DEC

- 蓮華池研究中心於12月12日在該中心舉辦「105年度第四季研習暨志工年會」，邀請到衛福部草屯療養院陳靖文護理師講授「緊急醫療概述與訓練」，介紹蜂螫、蛇咬、骨折、外傷等急救處理方式；以及蜂神養蜂場王智聰先生講授「蜂的秘密」，分享養蜂技巧、蜜蜂習性和蜜蜂行為的意義等，以增進同仁及志工們的自然知識及野外防護能力。
- 本所與中興大學實驗林管理處、行政院農業委員會茶葉改良場於12月17日至18日假惠蓀林場合辦「2017希望之樹暨茶產業文化節」活動，並負責提供油茶生態展示，包括：海報、商品展出、現場榨油、油品品嚐、有獎徵答等，內容豐富有趣。而榨油時不斷飄出的香味，更吸引遊客紛紛前來品嚐茶油，充分達到寓教於樂的目的。
- 森林經營組與蓮華池研究中心於12月20日假該中心舉辦「疏伐作業觀摩會」，由黃裕星所長主持開幕。會中介紹森林認證之目的、方法及蓮華池研究中心申請認證之經驗分享，以及講授人工林疏伐作業之制訂標準工作量與友善環境之集運技術等，以利參加者能精進實務，早日達成人工林永續經營的目標。

Major Events

JANUARY–DECEMBER 2016

JANUARY

- Hosted by the Director General Dr. Star Huang, the TFRI held a media event of "Managing mountains and have forests on the focus—in the occasion of TFRI technical film presentations" on 5th of January. Four short films of general science interests: "A little secret of Taiwan barbets living in the city;" "Sustainable management of agroforest in mountainous areas;" "Bamboo mountains, bamboo talks;" and "Let us taking care of tree health together." The presentation aims to instill in people how to engaging in ecological conservation practices in addition to concerning with the forestry developments.

- On January 21st, at the TFRI headquarter, a "Third ISA international tree doctors certification and completion of tree tending workshop" was held and hosted by the Director General Dr. Star Huang. In the event, a total of 40 tree doctor certificates were granted, including three passing the English test and 37 passing the first time Chinese test. In the meantime, 49 students were given the graduation certificate of the tree tending workshop. These represent a giant step in establishing a tree doctor system and promoting tree tending education.

- From Jan. 27 to Feb. 1, the Division of Technical Services held "2015 end of term experimental forest demonstration management business review and 2017 preplanned case evaluation." The event was led by Director General Dr. Star Huang with the members of experimental forest management team and visited Lienhwachih, Liukuei, Taimalee, and Fushan Research Centers for on-site inspection.

- On Jan. 30, TFRI co-hosted with the Dept. of Horticulture and Landscape, National Taiwan University, Taiwan Horticultural Welfare Promotional Society, and the Human and Plants Society of Republic of China an event at the TFRI "the 2016 Taiwan-Japan Gardens and Forests Healing and Environmental Welfares Symposium." In the meeting, President of Tokyo Agricultural University and Japanese Horticultural Practices Welfare Association, Dr. Ishiya Shibuya; Japanese Horticultural Practices Welfare Association and Grade 1 architect Ms. Kumiko Sumido and Yoko Kimura met with domestic scholars and starting from each perspective and experience the importance of gardens and forests healing effect on modern human and natural landscapes.

FEBRUARY

- Three experts, Tokyo University Professor Hideo Sakai; President of Shimane Prefecture Log Transportation Association Mr. Shinohara; and Kagoshima Prefecture Log Production Association Bureau Chief Mr. Kamizono visited TFRI on Feb. 22, and presented respectively lectures on "Wire rope logging setup in steep slopes of Japan," "Practical aspects of setting up logging wire ropes," and "Bamboo collection and transportation in Kagoshima Prefecture, Kyushu." Director General Dr. Star Huang personally hosted the visitors and listened to the latest logging techniques together with more than 80 attendants.

- TFRI and a juridical association, Urban Forest Health and Beautification Association of Taiwan co-hosted at the TFRI an event on Feb. 24 "2016 tree risks assessment class," with Mr. Kevin K. Eckert of Arbor Global Inc. of USA, who is also a grand master with ISA tree art association certification presented the course personally. The contents include: an overview of risk management, evaluation of risk degree, evaluation of target objects, possibility of tree-falling, data analysis and risk classification etc. More than 50 persons attended the course.

- Teachers and students of Dashin Elementary School, Fushing Township, Changhua County visited Lienhuashih Research Center on Feb. 26 for a whole day of ecological exploration activities in their "Visiting a low

elevation Noah's Ark—Lienhuachih" program. Four of center's volunteer teachers took the task of interpreting to the visitors.

MARCH

- In order for the staff to understand certification of forest management (FM) objectives, scopes, and process, on March 2 and 7, the Lienhuachih Research Center undertook a three-hour staff training entitled "Understanding FSC™ FM system operations and establishment of management system complying with the FSC™ standard."

- TFRI in a bid to support the "Taking seedling to travel" activity of Arbor Day, on March 12, hosted by the head of Technical Service Division, Yan-chang Chen and Wutong Environmental Integration Foundation, simultaneously distributed seedlings of 15 endemic tree species of Taiwan Aglaia, podocarpus, small-leaf elm etc., a total of 5,000 plants at Taichung, Hsinchu, and Taoyuan stations of Taiwan High Speed Rail, and providing planting information inquiry. Passengers eagerly took up the seedlings and planted them everywhere. Thus effectively promoting greening and environmental protection concepts

- On March 14th, the Lienhuachih Research Center held "First season ecological study for volunteer workers" activity. Dr. Wen-long Lin of Taichung City Wild Bird Rescue Association was invited to lecture on ecological diversity and methods of surveying for fish and aquatic insects. The participants responded with enthusiasm.

APRIL

- From April first to August 30, the Hengchun Research Center and Pingtung Forest Management District of Taiwan Forestry Bureau co-hosted a "Special exhibition of small diameter log crafts" at the tourist center of Kenting National Forest Recreational Area. The contents included 27 sets of wooden crafts and other cultural creative merchandises produced by the TFRI and the teachers and students of the Dept. of Traditional Crafts and Creative Designs of National Kaohsiung University. In the interim, special topics lectures on tree pruning, legality of lumber, and links in forest management and green consumption were provided by the Divisions of Forest Management and Forestry Economics. There were several community directed DIY courses as well, receiving tremendous reverberation.

- On April 7, the TFRI together with the Forestry Section of Miaoli Senior Agricultural and Industrial School held at Beishih Li of Nanchuang Township, Miaoli County a "2016 logging technology training class," inviting Mr. Chunjong Wu, a logging expert with the Forest Conservation Business Department of Retired Servicemen Council, Executive Yuan to preside over the class. The course contents included "introduction, usage and maintenance of chain saws," "practical operations of chain saws," "logging and reforestation operational practices" etc. The students were left with the professional lecture and hand-on experience with the chain saws with indelible impressions.

- In a bid to apply for the Forest management (FM) certification of the Forest Stewardship Council (FSC™), the Lienhuachih Research Center was visited by Senior Auditor Mr. Kaojun Chao of the Certification Department, Bureau Veritas Group, a third-party certification company, during April 13 to 15 and conducted the pre-review of the certification processes. The pre-review meeting was hosted by the Deputy Director General Dr. Chyi-rong Chiou and the Center Director Dr. Yuan-juei Hsu led various staff in charge of different aspects to illustrate their work on-site. The review items included documentary check, nursery management, management of various experimental plots, habitat monitoring and management of high conservation value species, natural and plantation forests survey management etc. In the meantime, units adjacent to the Research Center and stakeholders groups were interviewed to understand the operations of forest management on various aspects.

- Assistant Researcher Ms. Chia-chun Hsu of the Division of Botanical Garden in her bid to study "Forest health and ecological management of Pacific Northwest of the USA," went to the World Forestry Center, Portland, Oregon, USA from April 18 to October 19 for a study stint of half-a-year.

- A famous paper fiber identification expert of Mainland China, also a senior engineer Ms. Chiu-hwa Wang; Company Director Mr. Bing Gung, Chen-teh Kung Co. of Beijing, China; and Ms. San Wang of Chinese Cultural Relics Research Institute was accompanied by a domestic handmade paper expert, Mr. Kuo-tsai Wang visited the Division of Wood Cellulose on April 22 to the Paper Exhibition Room. They were received by Assistant Researcher Mr. Jiann-Gwo Shyu, who introduced to the guests the achievements of the institute in handmade paper art and mounting and restoration of Chinese painting and calligraphic artworks.

- On April 22 to 29, the TFRI held a "Theory and practices training class of industrial technology strategic planning," inviting Dr. Yi-ying Lee of Taiwan Agricultural Technological Resources Operation and Planning Association to lecture on how to strength systematic thinking of research staff, how to familiarize with strategic planning tools, and how to enhance quality of scientific research projects, so as to provide the "target clients" with creative and competitive research proposals.

MAY

- From May 3 to June 26, the TFRI invited Seeds Platform of Hualien County to hold a "People hide dreams, dream hide seeds, and seeds hide people" special exhibition at 323 Nanmending of Taipei Botanical Garden with three sessions of taste trial activities. Traditional crop seeds of Amy aboriginal people were shown and through imagery, the tribal elder's respective handling of old seeds was presented. Plant ashes, smoking and planting and harvesting generations by generations and changes in agricultural environments were also shown. In addition to provide people with localized traditional crops and their special gist, the exhibition also pays homage to seed hoarders and the tastes they protect.

- On May 5, the Deputy Director General, Dr. Chyi-rong Chiou led staff members of Divisions of Silviculture, Forest management, Watershed management, and Liukuei Research Center to the 13th Stand of the Liukuei Experimental forest in a bid to formulate removal of inferior trees and reforestation operations. The project was expected to cut squirrel-damaged Japanese cedar and replant with indigenous species of stout camphor, Taiwan camellia etc. to enhance timber production, and enrich the understory economic byproducts while taking care of the multiple management goals of good forest ecological development.

- From May 6 to June 15, the TFRI, together with the Wutong Environmental Integration Foundation exhibited research achievement of the Divisions of Forest Utilization, Forest Chemistry, and Wood Cellulose at the Youth Hall, Hsin-chu City government, entitled "Trees in our live," a 4-D experience exhibition. The Director General Dr. Star Huang also presented on the opening day a copy of "Tree risk assessment" to Hsinchu Mayor Mr. Chih-jian Lin and wished that citizens upon visiting the exhibition will be able to understand functions of trees, and to join in the volunteers of tree doctor work.

- From May 27 to August 31, the TFRI held a "Delicate wood with unique sheens—lathed wooden artworks and wooden lighting fixtures exhibition" at the Imperial Envoy's Lodging, Taipei Botanical Garden. The creative works of wood craftsmen Messrs. Chia-jian Chao and Chih-kuang Lue were displayed. Regardless whether lathing techniques endowed mill wood wastes or wind-felled wood with new life of delicate wooden craft, or engaging ingenious design to turn unremarkable contorted wood into fashionable lighting arts, these works repeatedly demonstrated the tender loving care of the creator to each piece of wood scraps, as well as the natural beauty of the woody materials. Three DIY activities were held during the exhibition and garnered great praises from the visiting people.

- The volunteer corps of Liukuei Research Center assisted the Division of Forest Protection in carried out an "I-tree urban forest benefits evaluation and analysis project." During the period from May to October, members were dispatched each weekend to various urban parks to partake in tree survey work for a total of more than 80 man-times and voluntary service time of 545 hours. They have completed more than 1000 entries to the I-tree survey information with rich results.

JUNE

- On June 6 and 7, the Fushan Research Center held a "Training course of aquatic plant management," initiated by the Director General Dr. Star Huang. The course included: An overview of aquatic plants, management of aquatic plants, fishery management and practices in aquatic ponds, monitoring and practices in aquatic plant ponds, hydrology and water quality management of aquatic plant ponds and on-site aquatic plant pond threading and practices etc. Through the course, students were instilled with knowledge of forest hydrological environment and management of aquatic plant ponds.

- On June 16, at the TFRI headquarter, a "Turning of luck starts with reading—the 6th book exchange activity" was held which display 1200 volumes of donated books. Through a second-hand book exchange mechanism, good books are endowed with a second life; and spread of knowledge shines again. At the same scene, mosquito-repellent products technical transfer events were on display as well, much like a carnival of intellectual properties with more than 70 persons attending.

- On June 16 and 17, the TFRI held a "First garden and forest healing bases promotional team working meeting" at the Lienhuachih Research Center. The event was hosted by the Director General Dr. Star Huang and invited 21 TFRI specialists with expertise on horticulture and landscape, plant essential oils, phytocids, animal resources appreciation, and wood working to partake. The meeting has ascertained the themes and methodology of setting Lienhuachih Research Center as a hub of forest healing worthy of further development. The path survey and preliminary planning of viewpoints were completed.

JULY

- The application of Lienhuachih Research Center to be certified with Forest management (FM) aspect of Forest Stewardship Council (FSC™) has received visitation of two auditors dispatched by Bureau Veritas Taiwan to handle the main review procedure of certification. The review items included: whether the deficits outlined in the pre-review stage were all corrected? And whether the Center's forest management operations comply with the 10 principles and all indicators of FSC™ FM? In the main review summary meeting, the two auditors provided only three minor defects needing correction and were agreeable on the rest of items. In other words, the FM of the center has already complied with the stringent certification standard of the FSC™. This represented all the efforts over the years by the Center's staff and also an important milestone in the management of national forests of Taiwan.

- A strong typhoon, Nepartak, hit Taitung County on July 8th, causing many precious trees in the county to suffer severe damages. The TFRI coordinated urgently on July 11th with Taiwan Urban Forest Health and Beautification Association and mustered 38 volunteers, including 12 tree doctors and 5 heavy-lifters, 2 bulldozers and 1 water spray vehicle, together with 45 drivers rushed to the site to rescue trees. The TFRI dispatched 3 internationally certified tree doctor colleagues to the task, in a bid to combine official and private sector forces to hasten the rescue of precious trees.

AUGUST

- On August 3 to 5 and 8th, the TFRI held "2016 mid-term reviews of experimental forest demonstrative management plans." The experimental forest management team members focused specifically with regard to: the garden and forest healing base planning of the Lienhuachih Research Center; the software facility upgrade of Shanping Scientific Zone; the pegging of Kaoshifo Experimental Forest, Hengchun Research Center as an important basis of special rare animals and plants; monitoring and damage prevention of sambar deer in Hengchun Research Center; and the aquatic plant pond management practices in Fushan Research Center. On-site inspection and improvement suggestions were provided.

- The president of the World Bamboo Organization (WBO), Dr. Michel Abadie was accompanied by retired honorary professor Dr. Shun-chao Wu and bamboo specialist Dr. Jing-ming Lue visited TFRI on August 5. They were met by the Deputy Director General Dr. Chyi-rong Chiou with senior researcher Tsai-hui Chen and associate researcher Yu-jen Lin. Bilateral exchanges on wide range topics of bamboo resources conservation, bamboo conversion and utilization and bamboo culture were made. Afterward the group visited Taipei Botanical Garden. The foreign visitor was much impressed by the garden providing neighborhood people with recreational space and rich educational functions.

- On August 22, directors of Japanese Water Resources Environmental Association Messrs. Ikujiro Wakai and Katsumi Nomura accompanied by a domestic bamboo specialist Dr. Jing-ming Lue visited the TFRI. They were received by the heads of Divisions of Technical Services and Watershed Management, Mr. Yan-chang Chen and Han-ming You with a senior research of the Division of Silviculture, Tsai-hui Chen. Bilateral exchanges on the topics of history and present status of management of Taipei Botanical Garden; development of protective forests for fishery in Taiwan; water nurturing function of forests etc. Afterward, the party toured special featured plants in Taipei Botanical Garden and the Chinese and Japanese buildings of Imperial Envoy's Lodging and 323 Nanmending.

- From August 22 to 24, at a 14-year-old Taiwan zelkova plantation of Kenjiao Farm, Gukeng Township, Yunlin County, the Division of Forest Management and Chungpu Research Center held a "Pruning and tending of plantation to protect the forest workshop." Twenty-two participants from Tse-sing Organic Farming Development Foundation, Wildness Protection Association, and students of National Taiwan and Chiayi Universities took parts.

SEPTEMBER

- Chief of Control Yuan, Bo-ya Chang and Convener of Financial and Economic Subcommittee, Mei-ling Yang, together with 8 other Control yuan officials accompanied by Deputy Minister Chang-liang Ong arrived in the morning of September 1 at the Lienhuachih Research Center for an inspection tour. The Director General Dr. Star Huang led Chief of the Center Yuan-juei Hsu received the party. After listening to a briefing and watching a wildlife monitoring film, they went to the nursery, natural forest, plantation and giant bamboo garden of the center for on-site inspection. The officials were impressed with the camellia tea oil experiments, management of the forest resources, bamboo conservation and maintenance and monitoring of biodiversity issues with much praises.

- On September 13, the Director General Dr. Star Huang attended the "2016 international wetland conference" of Construction and Planning Agency, Ministry of the Interior. On behalf of TFRI, he signed a "2016-2021 Inter-ministry wetland conservation cooperation agreement" together with the Construction and Planning Agency, MOI; Environmental Protection Administration, Executive Yuan; Forestry Bureau, Council of Agriculture; Water Resources Agency, Minister of the Economic Affairs; and Endemic Species Research

Institute, Council of Agriculture. The agreement aims to strengthen inter-ministry cooperation, coordination and sharing of wetland ecosystem knowledge and technology.

- From September 23 and October 2, the TFRI together with Taiwan Urban Forest Health and Beautification Foundation, and Wutong Environmental Integration Foundation held at Daan Forest station of metropolitan rapid transit an ecological exhibition entitled "Trees in our life." Through simply understood words and precious tree specimens, the exhibition conveyed to the visitor the benefits of planting trees and afforestation which importantly abate global warming. Endemic seed packs were distributed on the site, free guided tour and health inspection of bonsais were also provided, so that people can enjoy breath of the forest even in the rapid transit station.

OCTOBER

- From October 5 to 9, the TFRI together with Taiwan Plant and Tree Medicine Association, and Taipei City Bonsai Association held a "2016 Chinese-style bonsai show." In the interim, in addition to display some graceful bonsais, Japanese bonsai master Messrs. Taiga Urushibata and Masahiro Sasaki were invited to personally demonstrate the preparation of black pine and juniper. These not only deepen the exchange of Taiwan-Japan bonsai arts, but also led people in the world of bonsai art.

- A group of 7, led by chief of environment and forest of Miyazaki Prefecture Mr. Atsushi Otsubo, and a group of 6 from National Taiwan Technical University led by professor Hui-ping Wu visited the TFRI on October 11th in the afternoon. They were received by the Deputy Director General Dr. Chyi-rong Chiou, Head of Technical Services Division Mr. Yan-chang Chen, and senior researcher of the Division of Silviculture, Dr. Tsai-hui Chen etc. In addition to exchanges pertaining to the present status and future planning of forestry development, Taiwan timber and forest products import and export situations, logging information and technical support, and Japanese forest resources and logging and utilization issues. The guests were provided with a guided tour of 323 Nanmending in the Taipei Botanical Garden on its architecture, landscaping and management model.

NOVEMBER

- On November 5, the TFRI held an "One-hundred-and-twenty anniversary international symposium of the Taipei Botanical Garden." The event was presided personally by the minister of Council of Agriculture, Mr. Chih-hong Tsao for the opening ceremony. The symposium was based on the theme of "History of the botanical garden and future outlooks." In addition, the tight knitting of botany and history, social science, culture and environments were stressed. In the event, East Asian botanical gardens belonging to the Federation of Botanical Conservation were invited also, including Koishikawa Garden of Japan, Singapore Botanical Garden and National Arboretum of South Korea all dispatched persons to attend. The event with 240 attendants was grandiose.

- On November 5, on behalf of the TFRI, the Director General Dr. Star Huang signed a "Memorandum of technical cooperation on ecological monitoring and bio-meteorological observations." Bilateral agreement to share meteorological prediction, ecological monitoring, and information related to bio-meteorological observations, technical and research resources in the future. The agreement shall allow cooperative researches on ecological monitoring, bio-meteorological observations, and ecological environmental applications.

- The Lienhuachih Research Center applied for a Forest Management (FM) international certification system

by the Forest Stewardship Council (FSC™). After completing pre-review, main review procedures, finally a FSC™ FM system certificate, the first for a national forest in Taiwan, was granted. The center chief Dr. Yuan-juei Hsu came to the "Lienhuachih Research Center, Taiwan Forestry Research Institute FSC™ FM system certification granting ceremony and symposium on national forest certification" at the TFRI headquarter and officially received the certificate. The granting ceremony was hosted by the Director General Dr. Star Huang, and Bureau Veritas Taiwan Deputy President Mr. Chiu-long Tan presented the certificate. Minister of Council of Agriculture, Mr. Chih-hong Tsao, Examination Yuan member Dr. Ya-nan Wang, Taiwan Forestry Bureau Chief Hua-ching Lin, President of Taiwan Forest Certification Development Association Jon-shi Liu etc. A total of 113 honorable guests were present at the ceremony which transpired smoothly.

- On November 12, the TFRI and Chinese Forestry Association held at the TFRI headquarter a "2016 capacity enhancing workshop for forestry researchers." The event was chaired by the Director General Dr. Star Huang and the participants included TFRI staff and graduate students from the pertinent departments in universities. The course contents encompassed "a new paragon of forestry research: application of information technology;" "systematic research thinking;" "experimental design and analysis in forestry research;" "writing techniques of drafting a forestry research paper;" and "trends and positioning of forestry researches" etc. Research capacity of the participants was expected to be enhanced through the effort.

- From November 18 to 27, The TFRI and Chinese Floral Arts Foundation, Wutong Environmental Integration Foundation held a floral show entitled "Exclamation of flowers present at the 323-botanical garden," at 323 Nanmending, Taipei Botanical Garden. Materials from the plants of the botanical garden were used for the floral show so as to instill in people different perspectives of viewing plants. The themes of the display included: turning food into floral art "food is paramount for people;" graceful aquatic plants "in a corner of water;" floral arts using ferns to create the unique "elegance of ferns" etc. Regardless of the floral art designs or the spatial arrangement, visitors piled praises on the event.

- On November 22, at the TFRI headquarter the Division of Technical Services held a "2016 Introduction to simplified evaluation table and seed person training course." The event invited lecturers from Agricultural Technology Research Institute Foundation to provide evaluation of technical values and the detailed use of simplified evaluation tables, so as to elevate the self-evaluation capability of the researchers. A total of 52 persons attended the training.

DECEMBER

- On December 12th, the Lienhuachih Research Center held a "2016 fourth season research and volunteer annual meeting" at the center and invited nursing specialist Chien-wen Chen of Tsaotun Sanitarium, Ministry of Health and Welfare to lecture on "introduction and training to emergency medicine." During the talk, the treatments of bee sting, snake bite, broken bone, external laceration etc. were described. Mr. Chih-tsong Wang, proprietor of Fong-sheng Bee Farm was also invited to talk about "secrets of bees," sharing with the audience apiary techniques, habits of bees and meaning of bee behaviors etc. These enabled the staff and volunteers to gain natural knowledge and wildness defense capability.

- The TFRI together with the Experimental Forest Administration of Chung-Hsing University, and Tea Research and Extension Station, Council of Agriculture held a "2017 tree of hope and tea cultural festival" on December 17 and 18th at the Hui-sun Forest, Nantou County. The TFRI was responsible to provide displays of camellia tea oil ecology, including posters, commodities show, on-site oil pressing, oil tasting and bonus questions etc. The contents were rich and interesting. The aroma emanating during the oil pressing attracted tourists to taste tea oil, attaining great educational value in the amusing activities.

- On December 20, the Division of Forest Management held with Lienhuachih Research Center a “Forest thinning operation workshop” at the center. The opening was hosted by the Director General Dr. Star Huang. In the event, the objectives, methodology of forest certification, and the experience of Lienhuachih Research Center in the application process were shared. In addition, standard work load and environmental friendly logging techniques for plantation forest thinning operation were lectured on to allow participants to advance their practical capability and to arrive at the goal of sustainable plantation management earlier.

國內外學者專題演講

日期	講　　題	演講者	職稱	服務機關
02/22	日本之陡坡地集材架線	酒井秀夫 Hideo Sakai	教授	東京大學大學院農學生命科學研究科
02/22	架線集材實務	篠原憲 Ken Shinohara	理事長	島根縣素材流通協同組合理事會
02/22	日本九州地區鹿兒島縣之竹材集運	神園公博 Kimihiro Kamizono	局長	鹿兒島縣素材生產業協同組合連合會事務局
06/15	整合專家知識以增進植物多樣性快速評估工作之效率	林增毅	助理教授	臺灣大學 森林環境暨資源學系
08/16	日本竹產業振興議題與作法	渡邊政俊	事務局長	日本竹產業連合會
10/25	從地球系統觀點下森林在全球碳收支中的角色	Dr.Benjamin Poulter	研究員	美國NASA生物圈科學實驗室

科技研究專題演講

日期	講　　題	演講者	職　　稱	服務單位
01/26	劣化及災害衝擊下低海拔林地之復育研究	林朝欽	研究員	保護組
03/01	溫度變化對臺灣原生植物花期之影響	王相華	研究員	森林保護組
03/28	荒廢麻竹林管理與產筍量變化之研究	陳財輝	研究員	育林組
03/28	桉樹人工林二代林的萌芽更新	游漢明	研究員	集水區經營組
04/25	桉樹基因選殖、基因堆積技術與遺傳檢測	鍾振德	副研究員	育林組
04/27	本土森林植物之景觀產業開發	黃怡菁	副研究員	育林組
05/30	食用蕨類之研發及種源保存	黃曜謀	特聘研究員	育林組

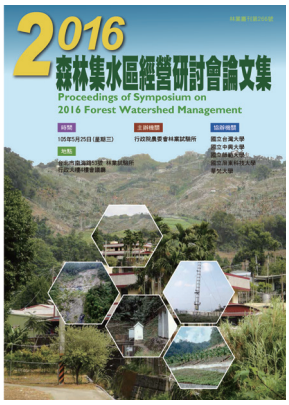
科技研究專題演講

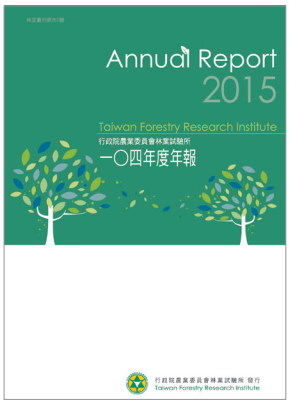
日期	講　題	演講者	職　稱	服務單位
05/30	國有林出租造林地違規使用改正經營方法之研究	陳芬蕙	特聘研究員	育林組
06/27	重大林木病蟲害健康管理及防疫平台之研究	汪澤宏	助理研究員	保護組
06/27	臺灣景觀林的外來種植食性昆蟲研究	董景生	副研究員兼組長	植物園組
07/25	臺灣低海拔野生蘭之調查及繁殖研究	鐘詩文	助理研究員	植物園組
07/25	臺灣萍蓬草遺傳資源保存及推廣利用之研究	朱麗萍	助理研究員	植物園組
08/29	都市林經營效益改良之研究	王巧萍	副研究員	育林組
08/29	應用多期福衛二號植生指標分析六龜試驗林地區崩塌地變遷影響	謝漢欽	研究員	森林經營組
09/30	耐逆境牛樟、泡桐與雜交桉品系選拔之造林試驗	何政坤	研究員兼組長	育林組
09/30	人工林不同林況以不同疏伐方法之採運作業研究	邱志明	研究員兼組長	森林經營組
10/31	桉樹優良品系採穗園維護管理與苗木培育	鍾振德	副研究員	育林組
11/28	海岸侵蝕危及新豐國家級濕地之紅樹林	王相華	研究員	森林保護組
11/28	福山植物園自然探索活動之設計研究	范義彬	副研究員	太麻里研究中心
12/26	重要經濟造林樹種之保健活性成分分析	洪昆源	助理研究員	森林化學組
12/26	改善紙質文物裝裱平整度之研究	徐健國	助理研究員	木材纖維組

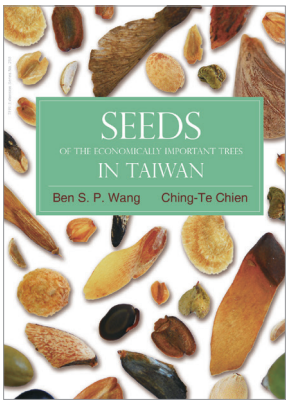
出版品

圖書類｜林業叢刊

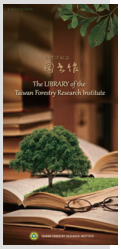
刊號	題名	作者	出版日
266	2016森林集水區研討會	林壯沛	5月
267	行政院農業委員會林業試驗所104年度年報	林業試驗所年報編輯委員會	5月
268	seeds of the economically important woody plants in Taiwan	Ben S.P. Wang Ching-Te Chien	11月
269	臺北植物園120周年紀念文集	董景生、林奐宇	11月
270	2016年平地造林試驗及監測研討會論文集	鍾智昕、唐盛林 彭炳勳	12月







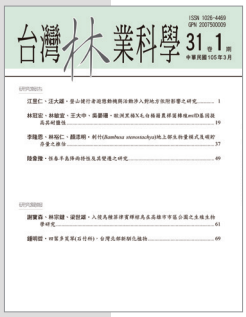




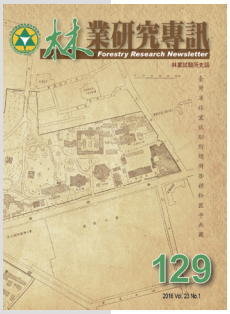
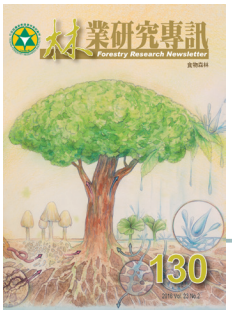

非圖書類｜推廣摺頁

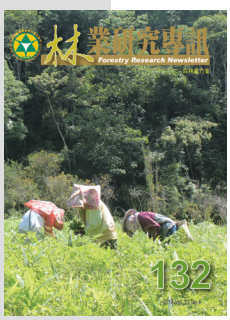
刊號	題名	作者	出版日
133	南門町323(日文摺頁)	朱麗萍、董景生	7月
134	林業試驗所圖書館	張勵婉	10月
135	林業試驗所圖書館(英文版)	張勵婉	10月
136	樹木褐根病—診斷鑑定與管理	吳孟玲、莊鈴木、傅春旭	7月
137	繽紛花現—臺北植物園開花紀實	鄭美如	8月
138	臺灣穗花杉開花結實	鍾振德、簡慶德、葉翠華 李玉珍、陳建帆、陳正豐	12月

非圖書類｜期刊



刊名	卷期（總號）	總編輯	出版日
臺灣林業科學	31卷1期	林朝欽	3月
	31卷2期	林朝欽	6月
	31卷3期	林朝欽	9月
	31卷4期	林朝欽	12月
林業研究專訊	23卷1期	董景生	2月
	23卷2期	董景生	4月
	23卷3期	董景生	6月
	23卷4期	董景生	8月
	23卷5期	董景生	10月
	23卷6期	董景生	12月



技術移轉案件

技術名稱	單位	創作人	件數	授權種類	年限
筆筒樹孢子繁殖體系的建立	森林保護組	傅春旭	1	非專屬	5
樹木外科手術之施作流程—續約案	森林保護組	傅春旭	2	非專屬	5
微波快速萃取精油之裝置及技術	福山研究中心	陳正豐	1	非專屬	5
青剛櫟印度松露菌根苗之接種技術	森林保護組	傅春旭	2	非專屬	5
樹木注射技術	森林保護組	吳孟玲	1	非專屬	5
樹木褐根病防治檢驗流程及檢體檢驗標誌之製作一續約	森林保護組	傅春旭	2	非專屬	5
樹木褐根病防治檢驗流程及檢體檢驗標誌之製作	森林保護組	傅春旭	1	非專屬	5

臺灣林業科學

作者	英文題目	中文題目	頁數
江昱仁、汪大雄	Evaluation of Recreation Motivation and Activity Involvement in Affecting Place Attachment by Hikers	登山健行者遊憩動機與活動涉入對地方依附影響之研究	31(1): 1-17
李隆恩、林裕仁 顏添明	Using Allometric Models to Predict the Aboveground Biomass of Thorny Bamboo (*Bambusa stenostachya*) and Estimate Its Carbon Storage	刺竹(*Bambusa stenostachya*)地上部生物量模式及碳貯存量之推估	31(1): 37-47
陸象豫	Study of Rainfall Characteristics and Their Changes on the Hengchun Peninsula	恆春半島降雨特性及其變遷之研究	31(1): 49-60
陳財輝、汪大雄 王仁	The Trend of Growth Characteristics of Moso bamboo (*Phyllostachys pubescens*) Forests under an unmanaged Condition in Central Taiwan	臺灣中部地區放棄經營的孟宗竹林生長性狀變化趨勢	31(2): 75-87
廖俊奎、周富三 許再文	Carex echinata Murray (section Stellulatae: Cyperaceae), a Newly Recorded Sedge in Taiwan	臺灣新紀錄種莎草科薹屬植物—刺苞薹	31(2): 143-147
葉耕帆、范義彬	Insect Diversity Survey of True Bugs (Hemipera: Heteroptera) in the Lienhuachih Area	蓮華池地區異翅類(半翅目：異翅亞目)昆蟲多樣性調查	31(3): 149-159
葛兆年、張靖 許詩涵	Sexual Differences in Plumage Color and Body Size of the Taiwan Barbet (*Psilopogon nuchalis*)	五色鳥兩性在羽色及體形上的差異	31(3): 161-168
林裕仁、潘薇如	Feasibility Analysis of Wood Bioenergy on the Current Energy Supply in Taiwan	木質能源於國內能源利用之評估分析	31(3): 169-180
鍾振德、洪西洲 簡慶德	Effects of Cross Pollination on Seed Production and the Inheritance of Chloroplast DNA in *Keteleeria davidiana* var. *formosana*	臺灣油杉人工授粉對種子生產效應與葉綠體DNA遺傳	31(3): 181-197
陳舜英、陳芬蕙 黃裕星、何政坤 簡慶德	Studies of Seed Germination and Dormancy of the Tree Species Michelia compressa and Pachylarnax sinica (Magnoliaceae)	木蘭科烏心石與華蓋木種子發芽休眠之研究	31(3): 199-213
陳明男、廖天賜	The Influence of Temperature on the Photochemical Efficiency of Photosystem II in Podocarpaceae Seedlings from Different Regions	溫度對不同地理分布的四種羅漢松科苗木PSII效能之影響	31(3): 215-226
葉銘哲、鍾智昕 林謙佑、林奐宇	A Case Study of Bamboo Forest Resources and Land Management on Slopeland in Tainan	臺南市山坡地竹林資源調查與土地管理之研究	31(3): 257-269

臺灣林業科學

作者	英文題目	中文題目	頁數
黃國雄	Effects of Carbonization Temperatures in an Earthen Kiln on the Properties of Bamboo Charcoal	土窯炭化溫度對竹炭性質之影響	31(4): 285-291
張藝翰、王暉 劉和義、呂碧鳳 林謙佑、塗三賢	Metathelypteris flaccida (Blume) Ching (Thelypteridaceae; Polypodiales), a Newly Recorded Fern in Taiwan	臺灣新紀錄蕨類：薄葉凸軸蕨	31(4): 323-330
林朝欽、麥舘碩 陸聲山	Federation of Ecological Data Repository of EAP-ILTER	亞太長期生態研究網之生態資料聯合查詢	31(4): 337-342

其他學術期刊

作者	題目	書名期刊	卷(期)、頁碼、審查編號	TCCC/SCI/EI
Chien-Chang Shen, 洪昆源 Jenifer Chen, Li-Jie Zhang Zhi-Hu Lin, Hung-Tse Huang Hui-Ling Cheng, Yao-Haur Kuo	Antioxidant and Anti-nitric Oxide Components from Quercus glauca	Chem.Pham.Bull	60(7): 924-929	SCI
Li Yaung Kuo, Cheng Wei Chen Wataru Shinohara, Astushi Ebihara 黃曜謀, Hiroshi Kudoh, Hirotoshi Sato Wen Liang Chiou	Not only in the temperate zone: independent gametophytes of two vittarioid ferns (Pteridaceae, Polypodiales) in East Asian subtropics	Journal of Plant Research	DOI: 10.1007/s10265-016-0897-x	其它
張登翔、謝幸媚、陳志雄 陳遠寧、朱麗萍、蔡麗琴	以葉綠體DNA條碼進行盜採珍貴林木物種鑑定之評估	刑事科學期刊	81: 83-98	其它
Eric Schuettpelz, Wen-Liang Chiou Harald Schneider, Alan R. Smith Peter Hovenkamp, 張藝翰 Li-Yaung Kuo, Ho-Ming Chang Yi-Shan Chao, Cheng-Wei Chen	A community-derived classification for extant lycophytes and ferns	Journal of Systematics and Evolution	DOI: 10.1111/jse.12229	SCI
黃菊美、杜清澤、林國銓	綠葉在三處生育地分解之養分動態變化	國家公園學報	26(2): 28-40	其它
Chih-Da Wu, Chi-Chuan Cheng 張哲彰, Chinsu Lin, Kun-Cheng Chang Yung-Chung Chuang	Gap Shape Classification using Landscape Indices and Multivariate Statistics	SCIENTIFIC REPORTS	DOI: 10.1111/jse.12229	SCI
Yutaka Notsu, Junsuke Yamasako 汪澤宏	Biological Notes on Curculionini Weevils Known from Taiwan (Coleoptera: Curculionidae)	Japanese Journal of Systematic Entomology	22(2): 145-146.	其它
張東柱、姚瑞禎、傅春旭	土肉桂、陰香、澳洲茶樹及臺灣扁柏四種精油抗褐根病菌之評估	中華林學季刊	49(1): 23-32	其它
江昱仁、汪大雄	Evaluation of Recreation Motivation and Activity Involvement in Affecting Place Attachment by Hikers	Taiwan Journal of Forest Science	31(1): 1-17	EI
黃裕星、洪挺軒、陳昭翰 汪澤宏、劉則言、吳孟玲	(2016)葡萄座腔菌屬病原菌為引起臺灣木棉潰瘍病與苦楝流膠病之可能病原	Journal of Plant Medicine	58(1): 39-44	其它
林朝欽、麥館碩、陸聲山	Federation of ecological data repository of EAP-ILTER	Taiwan Journal of Forest Science	31(4): 337-342	EI

其他學術期刊

作者	題目	書名期刊	卷(期)、頁碼、審查編號	TCCC/SCI/EI
Shun Kobayashi, Tetsuo Denda Chi-Cheng Liao, 伍淑惠 Yu-Hsiu Lin, Masako Izawa	Squirrel pollination of Mucuna macrocarpa (Fabaceae) in Taiwan	Journal of Mammalogy	97(7): 1-9	SCI
范素瑋、何東輯、林旭宏 沈明雅	臺灣中部烏石坑地區森林下層植群與上層的關聯及其環境影響因子	臺灣生物多樣性研究	18(1): 29-49	其它
王培蓉、詹為巽、林俊成 吳孟珊	臺灣小規模私有林主之經營型態與合作意願之研究	中華林學季刊	49卷4期	其它
林俊成、許原瑞、詹為巽 王培蓉	國有林租地造林樹種調查分析	中華林學季刊	49卷3期	其它
何雅齡、廖宇賡	刻傷、低溫層積及延長光照對櫸樸櫟實發芽及初期生長之促進	中華林學季刊	49(2): 117-130	其它
何振隆	Study of organosolv pulping of non-wood fiber for making dissolving pulp	Taiwan TAPPI Journal		其它
Chia-Hsuan Sung, Chen-Te Tseng 汪澤宏, Yu-Chi Li, Jenn-Kan Lu	The complete mitochondrial genome of Babylonia borneensis (Gastropoda: Neogastropoda: Buccinidae)	Mitochondrial DNA Part A	27: 5,3534-3535	SCI
蘇俊峰、陳淑佩、汪澤宏 翁振宇、莊耿彰、謝廷芳	輪作制度對百合病蟲害發生的影響—以臺中后里地區為例	植保會刊	57(4): 83-102	其它
趙芝良、葉美智、洪貝甸 林奐宇、董景生	與民同在：應用品質特性排序評量法於臺北植物園使用者期望差距分析之研究	臺大實驗林研究報告	30(4)259-276	其它
陳柏豪、林昌賢、陳建帆 楊勝任	兩種臺灣新歸化植物-波葉青牛膽與樟葉西番蓮	國立臺灣博物館學刊	69(2): 1-14	其它
Ed-Haun Chang, 陳財輝 Tsai-Huei Chen, 許俊凱 Chih-Yu Chiu	Effect of 40 and 80 Years of Conifer Regrowth on Soil Microbial Activities and Community Structure in Subtropical Low Mountain Forests	forests	DOI: 10.3390/f7100244	SCI
林朝欽，陸聲山	生態學在巨量資料下的新視野	國家公園學報	26:69-74	其它

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Yu-Chang Su, 徐光平 何振隆	Composition, in vitro Anti-inflammatory, Antioxidant and Antimicrobial Activities of the Leaf Essential Oil of Machilus konishii from Taiwan	Natural Product Communications		SCI
彭元興、余世宗、徐健國	裱褙用紙之研製及性質分析	國立臺灣博物館學刊	69(3): 15-22	其它
張藝翰, Hui Wang, Ho-Yi Liu Pi-Fong Lu, 林謙佑, 塗三賢	Metathelypteris flaccida (Blume) Ching (Thelypteridaceae; Polypodiales), A Newly Recorded Fern in Taiwan	Taiwan Journal of Forest Science	31(4):331-8	EI
Hsueh-Ching Wang, Chiao-Ying Chou 邱祈榮, Guanglong Tian Chih-Yu Chiu	Humic Acid Composition and Characteristics of Soil Organic Matter in Relation to the Elevation Gradient of Moso Bamboo Plantations	PLOS ONE	doi.org/10.1371/journal.pone.0162193	SCI
邱祈榮, 林俊成, Tsung-Wei Liu Wan-Yu Liu	Assessing the recreational value of protective forests at Taitung Forest Park in Taiwan	Tourism Economics	22(5)	SCI
Yi-Ching Lin, Liza S. Comita Daniel J. Johnson, Mei-Ru Chen 伍淑惠	Biotic vs. Abiotic Drivers of Seedling Persistence in a Tropical Karst Forest	Journal of Vegetation Science	27(7)	SCI
Kuo, Li-Yaung, Huang, Yi-Jia Chang, Jen-Yu, Chiou, Wen-Liang	Evaluating spore genome sizes of fern and lycophyte: a flow cytometry approach	New Phytologist	DOI: 10.1111/nph.14291	SCI
楊勝任、陳柏豪、陳建帆 陳建文	Identity of a problematic Menispermaceae in Taiwan, Cissampelos pareir 5a L. var. hirsuta (Buch. ex DC.) Forman	Taiwania	DOI: 10.6165/tai.2016.61.27	其它
Jyh-Min Chiang, Ryan W. McEwan Marko J. Spasojevic, Helene C. Muller-Landau, I-Fang Sun 蘇聲欣, Yiching Lin Zueng-Sang Chen, Chien-Teh Chen Nathan G. Swenson	Functional composition drives ecosystem function through multiple mechanisms in a broadleaved subtropical forest	Oecologia	182(3): 829-840	SCI

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何振隆, Yu-Chang Su	Fiber Morphology and Pulping Potentials of Date Palm (Phoenix dactylifera) Leaf Parts from Iran	林業研究季刊		其它
林俞廷、施欣慧、黃尹則 林清山、陳啟予	Two species of beetle-associated Geosmithia in Taiwan	fungal science	31	其它
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T.Jung, 張東柱, J.Bakonyi D.Seress, 傅春旭, A.Perez-Sierra X.Yang, C.Hong, B.Scanu	Diversity of Phytophthora species in natural ecosystems of Taiwan and association with disease symptoms	plant pathology(2016)		SCI
王義仲, 林俊成, Wan-Yu Liu Chi-Chwen Lin, Shu-Hsin Ko	Tourists' Motivation, Satisfaction and Cognition on Urban Forest Parks in Taiwan	Journal of Forest Research	21(6): 261-270	SCI
Tlan-Chuan Hsu, 鐘詩文	Two new combinations in Polygonaceae for the Flora of Taiwan	Phytotaxa	Vol 270, No 1	SCI
Wei-Ting Liou, Pi-Fong Lu, 黃曜謀, Chih-Kai Yang	The confirmation of three Dryopteris species (Dryopteridaceae) in Taiwan	臺大實驗林研究報告	30(4): 293-302	其它
李宗宜、汪大雄、蘇德忠 陳財輝	阿里山石棹地區石竹林分結構及生物量	林業研究季刊	38(2): 73-82	其它
Tuo Yang, Li Lin, Li-Min Lu 鐘詩文, Hong-Lei Li Zhi-Duan Chen, Miao Sun Bing Liu, Min Chen Yan-Ting Niu	Tree of life for the genera of Chinese vascular plants	Journal of Systematics and Evolution	54(4): 277-306	SCI
葉耕帆、范義彬	蓮華池地區異翅類(半翅目：異翅亞目)昆蟲多樣性調查	臺灣林業科學	31卷第3期149-159頁	EI

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郭立園 (Li-Yaung Kuo) Jennifer M. O. Glowienka Victor B. Amoroso 董仕勇 (Shi-Yong Dong) 張藝翰、高資棟 (Tzu-Tong Kao) 王俊能 (Chun-Neng Wang) 邱文良 (Wen-Liang Chiou)	A revised framework of Dryopteris subg. Nothoperanema (Dryopteridaceae) inferred from phylogenetic evidence, with descriptions of two new sections	Systematic Botany		SCI
張淑華、陳芬蕙、何政坤	Propagation and bioreactor technology of medicinal plants - case studies on paclitaxel, 10-deacetylbaccatin III, and camptothecin	Medicinal Plants - Recent Advances in Research and Development	257-272	
葛兆年、張靖、許詩涵	五色鳥兩性在羽色及體形上的差異	臺灣林業科學	31(3): 161-168	EI
葛兆年、許詩涵、張靖	五色鳥(Psilopogon nuchalis)在自然與都市地景的繁殖成功率	國家公園學報	26:1-8	其它
何振隆、徐光平	Applying NIR Spectroscopy to the Analysis of Syringyl / Guaiacyl Ratio (S/G) in Lignin Monomers	Taiwan TAPPI Journal		其它
陳財輝、汪大雄、王仁	The Trend of Growth Characteristics of Moso bamboo (Phyllostacchys pubescens) Forests under an unmanaged Condition in Central Taiwan	Taiwan Journal of Forest Science	31(2): 75-87	EI
Tian-Chuan Hsu, 鐘詩文	Piper sarmentosum (Piperaceae), a Newly Naturalized Plant in Taiwan	林業研究季刊	38(1): 1-3	其它
林群雅、何政坤、許原瑞 張上鎮	利用頂空氣相層析法預測伽羅木醇型土肉桂葉子精油化學組成分	中華林學季刊	49(2): 151-164	其它
Chun-Lin Huang, Jui-Hung Chen Chung-Te Chang, 鍾振德 Pei- Chun Liao, Jenn-Che Wang Shih-Ying Hwang	Disentangling the effects of isolation-by-distance and isolation-by-environment on genetic differentiation among Rhododendron lineages in the subgenus Tsutsusi	Tree Genetics & Genomes	12:53: 00 PM	SCI

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李隆恩、林裕仁、顏添明	刺竹(Bambusa stenostachya)地上部生物量模式及碳貯存量之推估	臺灣林業科學	31(1): 37-47	EI
Xiao-Guo Xiang, Xiao-Hua Jin Xiang-Cheng Mi, Hai-Lang Zhou Jian-Wu Li, 鐘詩文, De-Zhu Li Wei-Chang Huang, Wei-Tao Jin Zhen-Yu Li	Biogeographical diversification of mainland Asian Dendrobium (Orchidaceae) and its implications for the historical dynamics of evergreen broad-leaved forests	Journal of Biogeography	43(7): 1310-1323	SCI
張俊文, Bing-Hong Huang Si-Min Lin, Chia-Lung Huang Pei-Chun Liao	Changes of diet and dominant intestinal microbes in farmland frogs	BMC Microbiology	201616: 33	SCI
Su, Yu-Chang, 何振隆	Essential Oil Compositions and Antimicrobial Activities of Various Parts of Litsea cubeba from Taiwan	Natural Product Communications	11(4): 515-518	SCI
YUAN-SHING PERNG I-CHEN WANG WU-HUNG CHUNG CHIH-PING CHANG, 何振隆	Effects of hot dispersion on the properties of deinked pulp	Cellulose chemistry and technology	50(1-2)53-60	SCI
Chun Hsien Lu, Yo Ching Liu Yuan Ting Hsu, Heng Long Wang 鍾振德	Enhancing Flower Stalk Emergence in Phalaenopsis by Red Light Supplementation	American Journal of Plant Sciences		其它
張藝翰, 黃曜謀 WEN-LIANG CHIOU	Systematics of Adiantum philippense complex (Pteridaceae, Polypodiales) in Taiwan	Phytotaxa	263(2): 113-121	SCI
T.Y. Lin, C.C. Wei, C.W. Huang C.H. Chang, 許富蘭, V.H.C. Liao	Both phosphorus fertilizers and indigenous Bacteria Enhance Arsenic Release into Groundwater in Arsenic-Contaminated aquifers	Journal of agricultural and food chemistry		SCI
葉銘哲、鍾智昕、林謙佑 林奐宇	臺南市山坡地竹林資源調查與土地管理之研究	臺灣林業科學	31(3): 257-69	其它

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邱志明, 簡慶德, Gordon Nigh	Density-dependent mortality in Taiwania cryptomerioides and Chamaecyparis formosensis stands in Taiwan	Cogent Environmental Science		其它
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陳明男、廖天賜	溫度對不同地理分布的四種羅漢松科苗木PSII效能之影響	臺灣林業科學	31(3)、215-226	EI
Tian-Chuan Hsu, Hsin-Chieh Hung 張藝翰	New additions to the fern flora of Taiwan (4)	Taiwan Journal of Biodiversity		EI
鐘詩文、許天銓	擬漆姑(Spergularia marina (L.) Griseb.)：臺灣石竹科新紀錄屬、種	臺灣生物多樣性研究	18(1): 1-5	其它
Singh S.K., 簡慶德, Chang I.F.	The Arabidopsis glutamate receptor-like gene GLR3.6 controls root development by repressing the Kip-related protein gene KRP4	Journal of Experimental Botany	67(6): 1853-1869	SCI
黃裕星、黃國雄、吳孟玲 林振榮	Detection of decay damage in iron-wood living trees	Journal of Wood Science		SCI
黃裕星, 黃國雄, 吳孟玲, TH Yang 林振榮	Detection of Termite Damage in Hoop Pine (*Araucaria Cunninghamii*) Trees Using Nondestructive Evaluation Techniques	Journal of Tropical Forest Science		SCI
陸象豫	Study of rainfall characteristics and their changes on the Hengchun Peninsula	Taiwan Journal of Forest Science	31(1): 49-60	其它

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Nien-Chih Hsiao Tzu-Cheng Chang, 許富蘭 Shang-Tzen Chang	Environmentally benign treatments for inhibiting the release of aqueous extracts from merbau heartwood	Wood Sci Technol		SCI
黃瓊璣	莫拉克風災後扇平溪整建工程之成效評估	中華防災學刊		
洪聖峰, Su-Feng Roan Tsu-Liang Chang, Hen-Biau King Iou-Zen Chen	Analysis of aroma compounds and nutrient contents of mabolo (Diospyros blancoi A. DC.), an ethnobotanical fruit of Austronesian Taiwan	Journal of Food and Drug Analysis	24(1): 83–89	
Fay-Wei Li, Li-Yaung Kuo, 張藝翰, Tian-Chuan Hsu, Hsin-Chie Hung, 黃曜謀 Wen-Liang Chiou, Carl J. Rothfels	Asplenium pifongiae (Aspleniaceae: Polypodiales), a New Species from Taiwan	Systematic Botany	41(1):	SCI
Xugao Wang, I-Fang Sun, Amy T. Wolf Thorsten Wiegand Nathan Jared Boardman Kraft Nathan Garrick Swenson 蘇聲欣, Stuart J. Davies Zhanqing Hao, Robert W. Howe Yiching Lin, Keping Ma Xiangcheng Mi	Stochastic dilution effects weaken deterministic effects of niche-based processes in species rich forests	Ecology	97(2): 347-360	SCI
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李沛軒, Shyuan-Wu Chen Wen-Liang Chiou, 黃曜謀 Ho-Yih Liu	Phenology of 13 fern species in a tropical monsoon forest of southern Taiwan	The International Journal of Plant Reproductive Biology	8(1): 87-97	其它
林裕仁、潘薇如	木質能源於國內能源利用之評估分析	臺灣林業科學	31(3): 169-180	EI

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朱榮三	讓我再次見到了你—災後重生的扇平森林生態科學園	23(6): 79-83

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研討會報告

作者	研討會名稱	論文題目	主辦單位
邱祈榮	土地利用碳管理一國家溫室氣體排放清冊土地利用計算研討會	國家溫室氣體排放清冊土地利用計算規劃	行政院農業委員會林業試驗所、國立臺灣大學森林環境暨資源學系
邱祈榮	土地利用碳管理一國家溫室氣體排放清冊土地利用計算研討會	國家溫室氣體排放清冊土地利業部門計算說明	行政院農業委員會林業試驗所、國立臺灣大學森林環境暨資源學系
邱祈榮	新能源與環境永續研討會	臺灣林業生質能源及碳匯發展策略	中華民國環境保護學會
邱祈榮、林裕仁	生物炭的應用與產業發展研討會	木竹炭燒製技術、固碳效益與產品應用	農業試驗所
周巧盈、邱祈榮、郭悌懿 李玲玲、邵廣昭、林政道	GEO BON Open Science Conference All Hands Meeting. Leipzig	(2016) Development and Assessment of Taiwan's Biodiversity Indicators	Group on Earth Observations (GEO)
邱祈榮、莊媛卉	第十一屆環境保護林經營管理研討會	生態系服務認證系統發展現況與展望	林業試驗所中埔研究中心
林俊成	「馬拉喀什氣候會議(COP22/CMP12/CMA1)觀察與因應」研討會	馬拉喀什氣候會議與農業調適	臺北大學
林佳瑩、林家弘、朱麗萍 洪國祥	中華林學會105年森林資源永續發展研討會	臺灣特有種牛樟族群遺傳結構以及來源地鑑定分析	中華林學會
Xian-cheng Lu, 黃菊美 Jun Chang, Cho-ying Huang	AGU Fall Meeting	Indirect Quantification Methods of Fine Root Temporal Dynamics in Near Tropical Wet Mountainous Regions	American Geophysical Union
王培蓉	2016年平地造林試驗研究監測研討會	以森林生態服務功能做為大農大富平地森林園區之主題式規劃構想	林業試驗所
蔡佳彬、湯適謙	2016年平地造林試驗研究監測研討會	平地造林混農林業經營方法及效益評估	林業試驗所
許原瑞、鍾振德、蔡佳彬	2016年平地造林試驗研究監測研討會	速生高纖維樹種之平地造林試驗	林業試驗所
吳俊賢	第九屆海峽兩岸森林經理學術研討會	臺灣森林認(驗)證的潛力及對永續林業發展的影響	中南林業科技大學

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作者	研討會名稱	論文題目	主辦單位
吳孟玲、莊鈐木	2016年平地造林試驗研究監測研討會	平地造林病蟲害健康管理研究	行政院農業委員會林業試驗所
邱志明、鍾智昕、彭炳勳 唐盛林	2016年平地造林試驗研究監測研討會	平地造林光蠟樹、杜英、楓香之疏伐研究	林業試驗所森林經營組
邱志明、鍾智昕、彭炳勳 唐盛林	2016年平地造林試驗研究監測研討會	平地造林混合林生長之探討	林業試驗所森林經營組
林裕仁	蓮華池研究中心FSC™森林管理驗證合格證書授證儀式暨國有林森林認證研討會	臺灣森林驗證的歷程、現況與展望	林業試驗所
張淑華、陳永修、何政坤 林元祥、林欣德、陳國章 陳媜、蘇德忠、吳濟琛	105年森林資源永續發展研討會	低海拔牛樟營養系檢定	中華林學會、國立屏東科技大學森林系、木材科學與設計系
詹為巽、林俊成	2016平地造林試驗研究監測研討會	從臺灣製材業現況看未來平地造林主產物初步加工可能合作夥伴	行政院農業委員會林業試驗所
陳一銘、葛兆年、李宜龍	2016平地造林試驗研究監測研討會	大農大富平地森林園區動物廊道之評價與展望	林業試驗所
陳一銘、何紋靈、翁瑞鴻	2016動物行為及生態研討會	光豐地區之野生動物與平地造林廊道功能初探	中興大學
李宜龍、陳一銘、陳立瑜 盧勇仁	2016動物及行為生態研討會	以蜻蜓相評估山村水田的多樣性保存	中興大學
楊正釧	1050820-第11屆環境保護林經營管理研討會	臺灣林木種子的儲藏技術	林業試驗所中埔研究中心
張勵婉、林謙佑、葉定宏 朱麗萍、張乃航、徐露玉	2016植樹造林試驗監測研討	平地造林木之裝飾產品開發及商品化：以風倒木為例	
葛兆年、許詩涵、陳一銘 王相華	2016平地造林試驗研究監測研討會	大農大富平地森林園區3種棲地類型的鳥類群聚比較	林業試驗所
葛兆年、陳一銘、王相華 許詩涵	2016平地造林試驗研究監測研討會	大農大富平地森林園區自然演替區鳥類與植被關係調查	林業試驗所
葛兆年、山夢嫻	第26屆環境教育學術暨實務交流國際研討會	五色鳥幸福守護環境教育課程發展與教學設計	中華民國環境教育學會

研討會報告

作者	研討會名稱	論文題目	主辦單位
邱志明	105年臺中市樹木醫學研討會—行道樹的規劃設計及維護管理	臺灣行道樹的管理	臺中市政府建設局
W. Y. Liu, K. T. Wu Y. Y. Su, 林俊成	The 5th International Faustmann Symposium	Optimal Pricing of the Carbon Trading Market Based on a Demand-Supply Model	School of Economics and Management Beijing Forestry University, China
范素瑋、趙偉村、張楊家豪 蘇聲欣、張勵婉、林岌克 伍淑惠、葉定宏、謝長富	2016臺灣越南生物多樣性保育研討會	Forest Dynamics Plots and Long-Term Plant Ecological Research in Taiwan	特有生物研究保育中心、林務局
宋國彰、范素瑋、林信輝 張瑜芳	4th international conference on Soil Bio- and Eco-engineering -"The Use of Vegetation to Improve Slope Stability"	Succession of plant communities in landslide sites remediated with exotic plant species.	The University of Sydney
彭炳勳、邱志明、葉媚媚 曹立松	中華林學會105年森林資源永續發展研討會	目視外觀評量與非破壞性檢測應用於樹木風險評估管理—以金門縣木麻黃行道樹為例	中華林學會
葉定宏、林照松	臺北植物園120週年紀念研討會	恆春熱帶植物園之前世今生	林業試驗所
范義彬	第十一屆環境保護林經營管理研討會	環境保護林害蟲管理之探討	林業試驗所中埔研究中心
張勵婉、邱祈榮、楊淳正	第十屆海峽兩岸森林動態樣區研討會	森林動態樣區及植群樣區資料應用於崩塌地物種復育之研究：以蓮華池地區為例	中國大陸
張勵婉、鄭美如、陳建文 陳燕章、林文智	森林生態與生物多樣性信息研討會	環境網路感測系統應用於生態學之研究：以蓮華池地區為例	中國大陸
林鴻志	臺北植物園120週年紀念研討會	臺北植物園腊葉館的修復與蛻變	林業試驗所
成瑋、謝漢欽	中華林學會105年森林資源永續發展研討會	視森林為複雜適應性系統－經營與育林觀點	中華林學會
成瑋	中華林學會105年森林資源永續發展研討會	視森林為複雜適應系統—經營與育林的觀點	中華林學會

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作者	研討會名稱	論文題目	主辦單位
謝漢欽、鍾智昕	中華林學會105年森林資源永續發展研討會	應用NDVI及均值調整影像分割法於崩裸地萃取—以六龜試驗林地區多期福衛二號影像為例	中華林學會、屏東科技大學森林系、木材科學與設計系
謝漢欽、潘巍中、鍾智昕 黃俊元	第十一屆環境保護林經營管理研討會	應用多期Landsat™植生指標偵測雲嘉南海岸防風林健康狀況	林業試驗所中埔研究中心
陳建帆、陳建文、鐘詩文 張藝翰、邱文良	臺北植物園120週年紀念研討會	林業試驗所植物標本館	林業試驗所
彭楨惠、陳正豐、邱琮珀	臺北植物園120週年紀念研討會	福山植物園—生態島嶼的綠處方	林業試驗所
王相華、陳建文、鄭美如 蘇聲欣、黃俐雯	中華林學會105年森林資源永續發展研討會	山羌對括葉樹葉片的攝食喜好	中華林學會
王相華	中華林學會105年森林資源永續發展研討會	泰雅族原住民的臺灣赤楊利用傳統知識	中華林學會
許原瑞	國有林森林認證研討會	國有林森林驗證在經營管理上之意義	行政院農業委員會林業試驗所
邱志明、唐盛林	105年森林資源永續發展研討會	紅檜與扁柏自我疏伐之探討	中華林學會
朱麗萍	兩岸女青年跨領域科學論壇研討會	牛樟之相關種親緣關係	福建女青年工作者協會
吳維修、陳建文	臺北植物園120週年紀念研討會	今昔影像—從臺北苗圃到臺北植物園	林業試驗所
傅念澤、黃于禎禧、郭傑仁 黃志堅、莊銘豐、關永才	臺灣兩棲爬蟲動物研討會	面天樹蛙雄蛙鳴叫特徵對雌蛙之偏好選擇	東海大學生命科學系
林奐宇、鍾智昕、陸聲山 王豫煌	臺北植物園120週年紀念研討會	空中看植物園—臺北植物園70年的轉變	林業試驗所
柳雨德、吳家禎、林世宗	中華林學會105年森林資源永續發展研討會	山櫻花基因組微衛星體序列開發	中華林學會
吳家禎、張鎔敏、陳芬蕙	中華林學會105年森林資源永續發展研討會	The study of chloroplast microstaellite in tea-seed oil	中華林學會
柳雨德、吳家禎、林世宗	中華林學會105年森林資源永續發展研討會	山櫻花全葉綠體序列分析與微衛星體序列探討	中華林學會

研討會報告

作者	研討會名稱	論文題目	主辦單位
趙榮台、李玲玲	中華林學會105年森林資源永續發展研討會	臺灣森林資源經濟的新面向—森林蜂蜜及蜂產品	中華林學會
謝翔至、孫銘源、王培蓉	中華林學會105年森林資源永續發展研討會	國際碳權基金與森林保育	中華林學會
張晉、王培蓉、林俊成	中華林學會105年森林資源永續發展研討會	建立從造林到生產的林產供需模式初探—以宜蘭南澳相思樹為例	中華林學會
王培蓉、張晉、林俊成	第26屆環境教育學術暨實務交流國際研討會暨第七屆兩岸四地可持續發展教育論壇	田中有樹—氣候變遷下抗衝擊的混農林策略	中華民國環境教育學會
張俊文	第四屆臺灣兩棲爬行動物研討會	臺灣西部低海拔地區之蛙類的冬季鳴叫活動	東海大學
楊蒼叡、林俊成、徐大興	105年森林資源永續發展研討會	太麻里研究中心10年生牛樟扦插造林地上部生物量調查	中華林學會
鍾智昕、邱志明、林奐宇彭炳勳、謝漢欽	105年森林資源永續發展研討會	應用無人載具監測杜英人工林孔隙疏伐後冠層動態	中華林學會
鄧書麟、傅昭憲、陳舜英黃瓊逸	105年森林資源永續發展研討會	臺灣與琉球群島蓮葉桐族之遺傳變異	中華林學會
吳孟玲、劉則言	105年森林資源永續發展研討會	植物疫病菌的恆溫環狀擴增法(LAMP)檢測方法研發	中華林學會、國立屏東科技大學森林系、木材科學與設計系
劉則言、吳孟玲	105年森林資源永續發展研討會	臺灣油茶葉部病害之研究	中華林學會、國立屏東科技大學森林系、木材科學與設計系
林俊成	中華林學會105年度學術論文發表會	以熵權重法評估南投縣社會經濟脆弱度	中華林學會、國立屏東科技大學森林系、木材科學與設計系
宋嘉軒、汪澤宏、曾振德陸振岡	臺灣水產學年會	婆羅洲鳳螺 (*Babylonia borneensis*) 粒線體基因體序列之研究	臺灣水產學會
陳明男、廖天賜	105年中華林學會—森林資源永續發展研討會	二種羅漢松屬苗木在不同溫度下對模擬斑光之非光化學消散	中華林學會、國立屏東科技大學森林系、木材科學與設計系

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作者	研討會名稱	論文題目	主辦單位
吳孟珊、林俊成	中華林學會105年度學術論文發表會	油茶與檳榔的生產成本與效益之研究	中華林學會、國立屏東科技大學森林系、木材科學與設計系
詹為巽、林俊成、陳溢宏 林柏亨	中華林學會105年學術論文發表會	臺灣現有製材產業訪查分析	中華林學會
董景生	臺北植物園120週年紀念國際研討會	植物園—為臺灣下一個世代保種	林業試驗所
塗三賢、林振榮	中華林學會105年度森林資源永續發展研討會	Detection of decay damage in iron-wood living trees by nondestructive techniques	中華林學會
鍾智昕, 塗三賢, Cho-Ying Huang Te-Hsin Yang, 林振榮	中華林學會105年度森林資源永續發展研討會	Determination of the properties of extruded tea leaf-plastic composites by NIR spectroscopy	中華林學會
胡元瑋、許俊凱、郭礎嘉 曾喜育、曾彥學	中華林學會105年度森林資源永續發展研討會	臺灣中部暖溫帶老齡常綠闊葉林的植群動態	中華林學會
何振隆	ICOIAM 2016 TAIWAN Conference	Stream distillation equipment of essential oils	國立虎尾科技大學
何振隆, Su Yu-Chang	ICOIAM 2016 TAIWAN Conference	Chemistry of essential oils	國立虎尾科技大學
何振隆、蘇裕昌	中華林學會105年森林資源永續發展研討會	九種龍腦香科樹種製漿適性之評估	中華林學會
徐光平、蘇裕昌、何振隆	中華林學會105年森林資源永續發展研討會	四種速生樹種應用於格拉辛紙之製備研究	中華林學會
劉則言、吳孟玲	2016真菌學術研討會	臺灣油茶葉部真菌之分離與分析	中華民國真菌學會
顧文君、馬復京、游漢明 許富蘭、朱紀實、夏滄琪	105年森林資源永續發展研討會	瓊崖海棠油與石栗油之分析與應用	中華林學會
林裕仁、潘薇如	中華林學會105年森林資源永續發展研討會	木質顆粒碳足跡分析與因應策略	中華林學會
林裕仁、邱祈榮、林俊成	新農業第一屆臺灣智慧農業機械國際研討會	Current status and prospects of woody bioenergy on forest sectors in Taiwan	國立虎尾科技大學

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作者	研討會名稱	論文題目	主辦單位
湯適謙、林昇煜、郭添枝	新農業第一屆臺灣智慧農業機械國際研討會	Good Helper of Forest Harvest Operations—Multi-Functional Wood Harvester	國立虎尾科技大學
湯適謙、林昇煜、郭添枝	新農業第一屆臺灣智慧農業機械國際研討會	Automatic control and mechanical analysis for multi-functional wood harvester	國立虎尾科技大學
劉癸君、張怡萱、傅昭憲	第十一屆環境保護林經營管理研討會	化滄為海桑田—中港園區十年綠美化的回顧與展望	中埔研究中心
鄧書麟、傅昭憲	第十一屆環境保護林經營管理研討會	平地造林樹種成樹移植作業程序之探討—以福木與蘭嶼羅漢松為例	中埔研究中心
蔡景株、傅昭憲	第十一屆環境保護林經營管理研討會	淺談各縣市植樹節活動現況與未來	中埔研究中心
黃俊元、張繼中	2016環境保護林經營管理研討會	臺東縣太麻里溪下游河岸洪氾區八種造林樹種之初期生長表現	林業試驗所
楊爵因(Jiue-in Yang) 張祁舜(Chih-shun Chang) 余冠毅(Guan-yi Yu)、施欣慧 林清山	2016 第25屆國際昆蟲年會	Nematode population associating with ambrosia beetles in Taiwan	國際昆蟲學會
汪大雄	第九屆海峽兩岸森林經理學術研討會	臺灣肖楠林分直徑分布生長模式之探討	中南林業科技大學
汪大雄	IUFRO Internatioal Symposium	Stand growth in mixed plantations of Calocedurs formosana and Michelia formosana in Taiwan	Japan Society of Forest Planning
洪昆源、黃俊元、蔡景株 洪州玄	2016年生醫年會	The Major Anti-depressant and Anti-inflammation Active Compound of Syringin and Caryophyllene Analysis from *Magnolia kachirachirai*	中華民國解剖學學會、臺灣生物化學及分子生物學學會、中華民國細胞及分子生物學學會
邱明賜、楊德新、林振榮	第四屆茶葉科技研討會	茶葉塑膠再生複合材之開發及耐久性研究	茶葉改良場
林朝欽	The 8th AP-BON Workshop	The Importance and Future Trends of Sharing Data on Biodiversity and Ecosystems: A Regional Perspective	Academia Sinica

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作者	研討會名稱	論文題目	主辦單位
胡正恆、陳芬蕙	2016年國際濕地大會	田園將蕪？北臺灣林下濕地的鳥獸多樣性	國家重要濕地保育計畫
徐中芃	第七屆海峽兩岸生物多樣性與森林保護文化研討會	日本的森林療癒-研究現況與森林療癒基地之案例分享	臺大實驗林
徐健國、彭元興	非破壞性文物材質檢測	裱褙用紙之研製及性質分析	國立臺灣博物館
董景生	2016 XXV International Congress of Entomology	Regulation of invasive tree-of-heaven, Ailanthus altissima, by its native pest, Eligma narcissus, from Asia to Europe	世界昆蟲學會
董景生	Consultation workshop on cost-effective and sustainable ex situ conservation techniques for woody, exceptional species native to the Southeast Asia region	Project the Ark for Taiwan Future Green	國際植物園保育聯盟
劉則言、吳孟玲、汪澤宏	植栽及樹木之醫療及健檢研討會	葡萄座腔菌屬病原菌在臺灣引起之木棉潰瘍病與苦楝流膠病	行政院農委會林業試驗所、臺灣植物及樹木醫學學會、臺北市盆景協會、香港園藝專業學會
施欣慧、陸聲山、陳啟予林俞廷、林清山	植栽及樹木之醫療及健檢研討會	林木常見小蠹蟲與其傳播真菌病害之研究	行政院農委會林業試驗所、臺灣植物及樹木醫學學會、臺北市盆景協會、香港園藝專業學會
吳孟玲	植栽及樹木之醫療及健檢研討會	林木褐根病LAMP快速檢測技術之研究	行政院農委會林業試驗所、臺灣植物及樹木醫學學會、臺北市盆景協會、香港園藝專業學會
吳孟玲	國內外樹木保育實務研討會	美國ISA年會心得分享	行政院農業委員會林業試驗所
吳孟玲	國內外樹木保育實務研討會	從風災看樹木健康管理	行政院農業委員會林業試驗所
徐嘉君	7th International Canopy Conference	Threat and opportunity: typhoon influence on the vascular epiphyte community in Taiwan	University of Roehampton
林振榮	1st Internal conderence on Intelligent Agricultural Machinery in Taiwan	Inspection and evaluation of decay damage in living trees by nondestructive techniques	雲林虎尾科大

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作者	研討會名稱	論文題目	主辦單位
劉瓊峰、許富蘭、王升陽 蔣慎思	臺灣保健食品學會與臺灣抗老保健學會2016年年會暨學術研討會	Ameliorating effects of hypertension and vascular function by Camellia brevistyla (Hayata) Coh. Stuart seed pomace ethanol extract in L-NAME treated mice.	臺灣營養學會
周珊沂、陳育涵、許富蘭 張上鎮、張惠婷	105年森林資源永續發展研討會	烷基肉桂醛類化合物抑制黴菌活性之評估	中華林學會
許富蘭、許俊凱、陳舜英 鄭美如	105年森林資源永續發展研討會	採摘時間對小果油茶種子採收特性之影響	中華林學會
許富蘭、鄧書麟、黃瓊逸 李鴻麟	105年森林資源永續發展研討會	9種商用木材及其ACQ處理材之1年接地田野試驗	中華林學會
劉恩妤、邱祈榮	2016森林資源保存與利用研討會	山櫻花物候模式研究	林業試驗所
周巧盈、邱祈榮、郭悌懿 李玲玲、邵廣昭、林政道	2016森林資源保存與利用研討會	生物多樣性指標建置與資料品質檢核機制	林業試驗所
胡正恆、陳芬蕙	2016森林資源保存與利用研討會	北臺灣林下遮蔭茶園與蟻相生態指標	林業試驗所
張淑華、何政坤、陳怡蒨 蔡錦瑩、陳媜、黃芷雲 呂汶玲	2016森林資源保存與利用研討會	臺灣粗榧毛狀根誘導與培養	林業試驗所
何政坤、陳永修、張淑華 蔡錦瑩	2016森林資源保存與利用研討會	南洋紅豆杉生產護膚機能產品之品種選拔與培育	林業試驗所
鍾振德、簡慶德、葉翠華 李玉珍、陳建帆、陳正豐	2016森林資源保存與利用研討會	臺灣穗花杉控制授粉與胚胎發育	林業試驗所
簡慶德、陳舜英、蔡伃涵 蘇信瑋、王玉婷	2016森林資源保存與利用研討會	鐵冬青、呂宋莢蒾、臺灣小檗和阿里山十大功勞種子發芽休眠之研究	林業試驗所
黃曜謀、曾梅慧	2016森林資源保存與利用研討會	蕨類隱性綠色孢子	林業試驗所
洪聖峰、何政坤、陳永修	2016森林資源保存與利用研討會	臺灣相思樹嫁接困難的原因推測	林業試驗所
吳家禎、張淑華、何政坤	2016森林資源保存與利用研討會	The study of chloroplast microsatellite markers in Cinnamomum kanehirae Hayata and its relative species	林業試驗所

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作者	研討會名稱	論文題目	主辦單位
林巖、陳振榮、曲芳華 鍾振德	2016森林資源保存與利用研討會	轉殖赤桉纖維素基因苗木之性狀分析	林業試驗所
黃曜謀, Feng-Chih Liu Li-Ju Ju, Chun-Mei Wang	2016森林資源保存與利用研討會	An aquatic but desiccation - tolerant plant Isoetes taiwanensis DeVol	林業試驗所
吳家禎, Shijiang Cao Zhangtian You, Shuisheng You Shutzong Lin, Liqian Guo	2016森林資源保存與利用研討會	Genetic diversities of Castanopsis carlesii Hayata in Taiwan and Fujian - Fuzhou Gushan as an example	林業試驗所
顧文君、馬復京、朱紀實 許富蘭	2016森林資源保存與利用研討會	木本植物種實油脂之分析	林業試驗所
李金梅、楊德新、趙偉成 林志憲、黃國雄	2016森林資源保存與利用研討會	建築用孟宗竹竹稈之性質評估	林業試驗所
陳怡蒨、陳盈如	2016森林資源保存與利用研討會	臺灣不同地區山胡椒精油含量與成分差異之研究	林業試驗所
黃怡菁、傅春旭、陳柏勳 何政坤、黃裕星	2016森林資源保存與利用研討會	山葵新經濟生產系統之初步評估	林業試驗所
陳永修、何政坤	2016森林資源保存與利用研討會	臺灣相思樹3年生種源後裔與栽植密度試驗	林業試驗所
周富三、林文智	2016森林資源保存與利用研討會	多納林道崩塌地先驅樹木的更新策略	林業試驗所
彭炳勳、邱志明	2016森林資源保存與利用研討會	花蓮兆豐地區造林劣化地復育研究	林業試驗所
馬復京、何政坤、張淑華 顧文君、游漢明、黃冬梨 謝勝國	2016森林資源保存與利用研討會	雜交麻瘋樹的生長表現及初步選拔	林業試驗所
陳財輝、汪大雄、蘇德忠 李宗宜	2016森林資源保存與利用研討會	阿里山石棹地區石竹林分結構及生物量	林業試驗所
趙榮台	第十一屆海峽兩岸蜜蜂與蜂產品研討會	臺灣林地養芻議	臺灣蜜蜂與蜂產品學會、臺灣養蜂協會、中國養蜂學會
邱志明、唐盛林、鍾智昕	第九屆海峽兩岸森林經理學術研討會	紅檜人工林不同林分密度生長與自我疏伐之研究	中南林業科技大學、宜蘭大學
吳家禎、張淑華、何政坤 許原瑞	2016機能性食品發展國際研討會	土肉桂	農業科技研究院

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作者	研討會名稱	論文題目	主辦單位
董景生	第35屆測量及空間資訊研討會暨國土測繪成果發表會	以參與式公民科學建立傳統生態智慧的民族植物園	國立政治大學
謝漢欽、鍾智昕、汪大雄	第九屆海峽兩岸森林經理學術研討會	應用多期福衛二號植生指標分析六龜試驗林地區崩塌地變遷影響	大陸中南林業科技大學
王巧萍	Joint Symposium – JaLTER Day	Nitrogen isotope dynamics during long-term litter decomposition and its implication for N cycle	北海道大學
Chung-Te Chang, 王巧萍	Joint Symposium – JaLTER Day	Nutrient cycling of subtropical forest ecosystem for 20 years: from observation to simulations	北海道大學
陸象豫	2016集水區經營研討會	以基流量推估森林集水區之水資源涵養功能	林業試驗所
黃瓊璡、謝漢欽	2016森林集水區經營研討會	試驗林集水區之崩塌潛勢評估模式應用和風險管理	行政院農業委員會林業試驗所
謝漢欽、鍾智昕、汪大雄	2016年海峽兩岸遙感/遙測研討會	應用多期福衛二號影像分析公私有林地崩塌變遷與地景結構影響	中華民國航空測量及遙感探測學會、中國地理學會環境遙感分會
吳孟玲	森林法樹木保護專章施行作法研討會	地方政府執行樹保專章之觀察	行政院農業委員會林業試驗所、社團法人臺灣都市林健康美化協會、國立臺灣大學園藝暨景觀學系
林壯沛、林介龍	2016森林集水區經營研討會	應用臨前降雨指數模式推估集水區暴雨流量歷線	林業試驗所集水區經營組
林壯沛、王秋嫻、林介龍	2016森林集水區經營研討會	租地造林地栽植果樹對水土流失影響之研究	林業試驗所集水區經營組
Ju-ching Chou, Yu-ting Yuan, 徐光平, Louis Kuo-ping Chao	2016生物技術暨生物工程國際研討會	The Protective Effects of Lapachol from LPS-induced Inflammation in Human Monocytic Leukemia Cells	Biotechnology and Biochemical Engineering Society of Taiwan(BEST), National Central University
Ju-Ching Chou, Ching-Yi Chu 徐光平, Louis Kuo-ping Chao	2016生物技術暨生物工程國際研討會	Anti-inflammatory bioactivity of genistein in fibroblast of skin	Biotechnology and Biochemical Engineering Society of Taiwan(BEST), National Central University
趙榮台	2016 23rd Pacific Science Congress	Gaps and inconsistencies in the global versus national invasive alien species listing	Pacific Science Association, Academia Sinica

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傅春旭	樹木外科手術技術精進研討會	臺日韓老樹保護之比較以樹木外科手術為例	行政院農業委員會林業試驗所、福田樹木保育基金會
湯適謙	2016中華林產事業協會學術論文暨研究成果研討會	迴旋式集材機機械臂及絞盤模擬力學分析	中華林產事業協會、臺灣大學生物資源暨農學院實驗林管理處
葉若鋆、吳典誼、陳姿穎李鴻麟	2016中華林產事業協會學術論文暨研究成果研討會	玉米桿纖維製漿造紙應用之研究	中華林產事業協會
葉若鋆、何宜庭、陳鈺凱詹雅琳、李鴻麟	2016中華林產事業協會學術論文暨研究成果研討會	薑黃植株再利用之研究	中華林產事業協會
徐光平、王益真、何振隆	2016中華林產事業協會學術論文暨研究成果研討會	四種速生樹種應用於格拉辛紙製備之研究	中華林產事業協會
林振榮、塗三賢	2016生物產業學術研討會	The use of spectroscopy to determine the properties and evaluation of extruded tea leaf-plastic composites	中興大學生物產業管理研究所
羅立偉、林振榮、楊德新	2016中華林產事業協會學術論文暨研究成果研討會	音響法於立木材質之應用以蕙蓀林場杉木為例	林產事業協會
曾俊偉、黃瓊璀、王豐仁	2016森林集水區經營研討會	水里溪上游崩塌潛勢區地質特性之研究	林業試驗所
曾俊偉、陳明杰、曾聰堯林介龍	2016森林集水區經營研討會	不同土地利用型態之淺層土壤孔隙蓄水能力之研究—以蓮華池農村地區為例	林業試驗所
邱祈榮	2016年臺灣地球科學聯合學術研討會TGA—福爾摩沙衛星國際服務主題場次	Overlook of FORMOSAT images involvement on international forest monitoring	財團法人國家實驗研究院
陳芬蕙、何可薏	2016兩岸濕地聯合研討會	2016兩岸濕地聯合研討會	嘉義大學生命科學系
邱志明	第七屆「海峽兩岸森林保育經營學術論壇」	臺灣扁柏天然下種更新與自我疏伐	臺灣森林休憩保育協會
許富蘭	苦茶油加工與機能性研討會	製油法對苦茶品質之影響	中國文化大學保健營養系
許原瑞、何政坤	2016年海峽兩岸植物品種檢定技術研討會	臺灣紅豆杉之品種選拔與檢定	中國 農業部種子管理局

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林朝欽	International Symposium on Long Term Ecological Research Network	Information Management for TERN and EAP-ILTER	National Institue of Ecology, Korea
林朝欽	The International Symposium on Forest Ecosystem Conservation and Management	From TERN to EAP-ILTER: An Experience of Promoting Ecological Information Managment	National Institute of Forest Science, Korea
劉一新	2015 森林集水區經營研討會		林業試驗所
林奐宇	2016 TCCIP Workshop—Applications of Climate Change Projection	A preliminary assessment of forest ecosystem sensitive to climate change in Taiwan	TCCIP(臺灣氣候變遷推估與資訊平台)
Kirschner Roland, 黃曜謀	2016植物多樣性與系統分類研討會	A high but poorly known biodiversity of fungi on Taiwanese ferns	臺灣植物分類學會
林奐宇、謝長富、胡哲明	臺灣植物分類學會年會	利用植物空間分布資料庫探討臺灣維管束植物的多樣性、特有性及地理親緣關係	臺灣植物分類學會
林奐宇, W. T. Chao C. F. Hsieh, J. M. Hu, T.Y. Chen	2016年亞太林業週—氣候變遷專案第二期計畫啟動會議	A Preliminary Assessment of the Impact of Climate Change on Vascular Plants in Taiwan. —Preliminary result and pilot sites	University of British Columbia
何可薏、陳芬蕙、胡正恆	2016年動物行為暨生態研討會	臺北新店四嵌水森林的蝙蝠聲紋與蛾類季節變化	國立中興大學
林俊成	國產木竹材產地證明驗證與合法木材國際貿易研討說明會	木材合法性與保證制度	行政院農業委員會林務局
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林朝欽、陸聲山、王豫煌	2016動物行為暨生態學研討會	農業長期生態研究站古坑農場之資源調查	國立中興大學

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宋一鑫、陸聲山、李青珍 葉文琪	2016動物行為暨生態學研討會	農業長期生態研究站誘集借坑性築巢蜂類及其應用評估	國立中興大學
陸聲山、林朝欽、王豫煌 周富三、吳孟玲	2016動物行為暨生態學研討會	測試i-Tree系統在臺灣都市林效益評估之適用性	國立中興大學
陸聲山、蕭明堂、宋一鑫	2016動物行為暨生態學研討會	觀霧地區人工巢箱虎頭蜂與蜜蜂類之利用	國立中興大學
甘哲山、張坤城、鄧書麟	105年易之森林植物學術研討會	臺灣產嘉賜木屬(楊柳科)之分類研究	中華易之植物森林研究學會
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吳偉嘉、張淑華 陳永修、何政坤 蔡韙任	外用機能性紅豆杉選種策略與護膚功效	農業生技產業季刊	47: 53-57
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林俊成、黃名媛 鄭伃萍	臺灣竹材與竹產品進出口現況分析	臺灣林業	42(5)
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汪大雄	2010年世界人工林資源及2005年竹資源變遷之簡介	臺灣林業	第42 卷第5 期
邱祈榮、陳乃維 林俊成	ISO制度融合森林驗證發展趨勢之探討	臺灣林業	42(4): 51-60
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陸聲山	他山之石—南非卡可路夫藍小灰蝶之保育	蝶季刊	2015冬季號8-12
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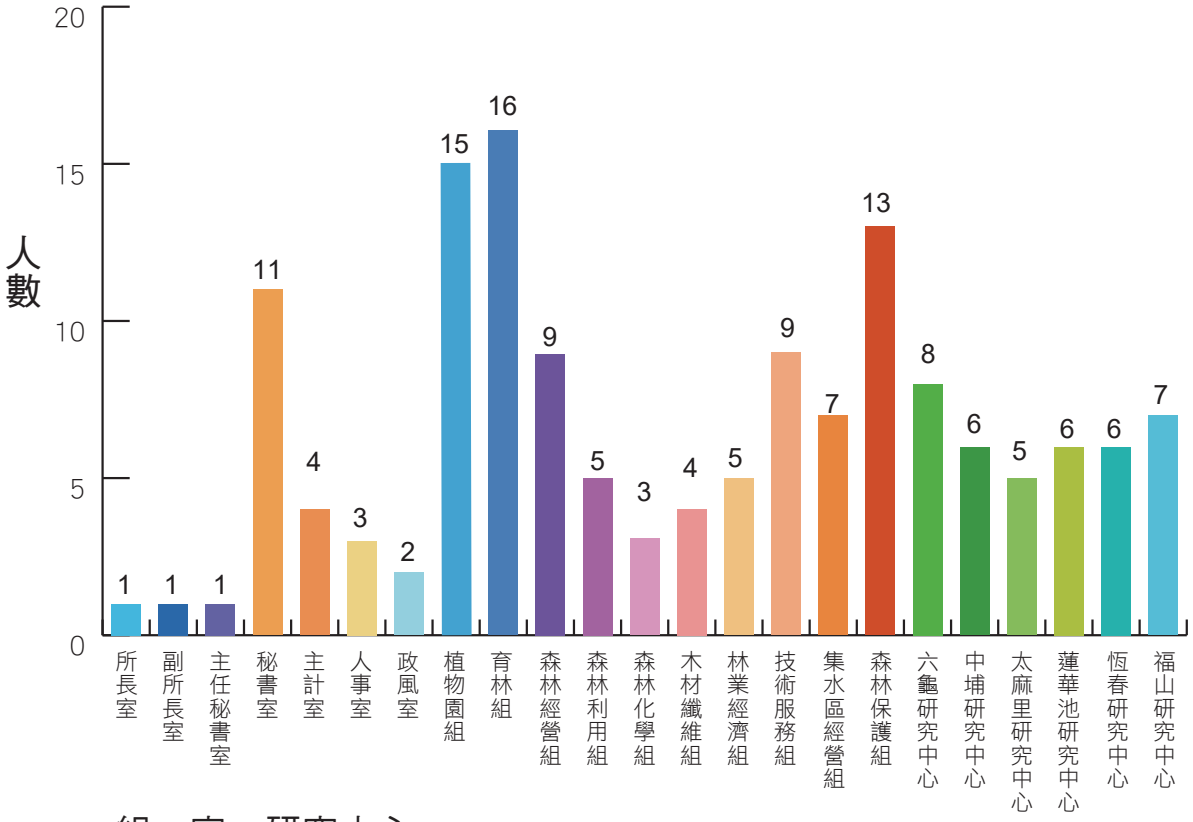
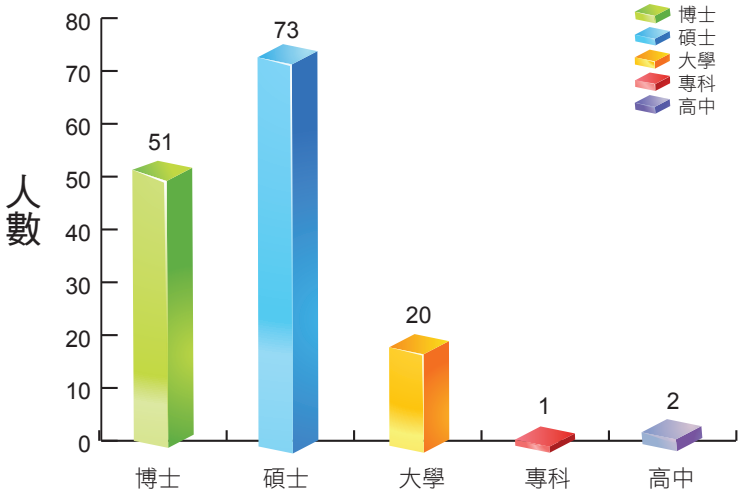
王培蓉	森林「廚餘」變玩具 小朋友玩得安全有保障	中廣 / 漁業廣播 / 壹周刊 / PCHOME/YAHOO...	
林振榮	樹木健康與安全性檢查和評估	林產工業	33(4): 235-246
林振榮	樹木風險評估之檢查等級	林產工業	33(3): 171-180
吳維修	祝臺北植物園120歲生日快樂！「廿四節氣植物」～慶典版假日導覽系列活動熱鬧登場	中央社、中時新聞網、聯合新聞網、環境資訊中心、Taiwan Today、華人今日網	

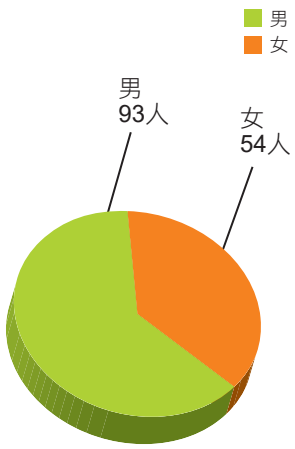
人力資源



組、室、研究中心
共計147人



教育程度



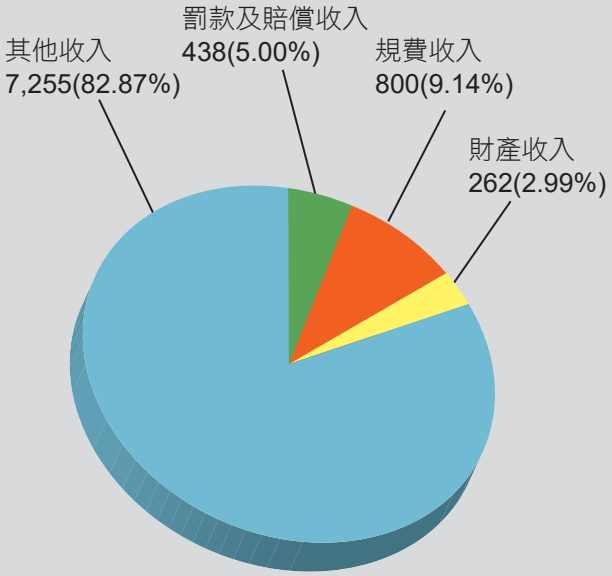
男女人數

財務預決算

(一)105年度預算

1.歲入：本年度歲入預算數8,755千元，較上年度11,173千元減列2,418千元，其主要內容如圖1。

2.歲出：本年度歲出預算數637,068千元，較上年度591,291千元增列45,777千元，其主要內容如圖2。

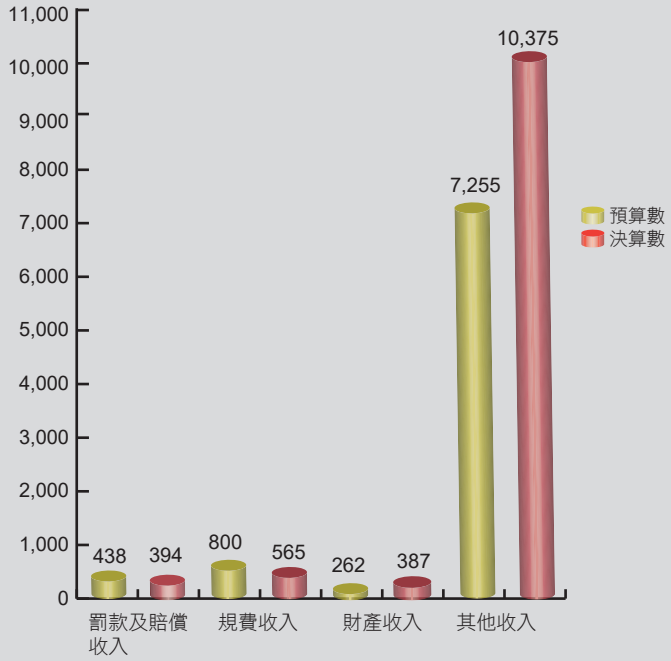


▲ 圖1. 105年度歲入預算主要內容（單位：千元）

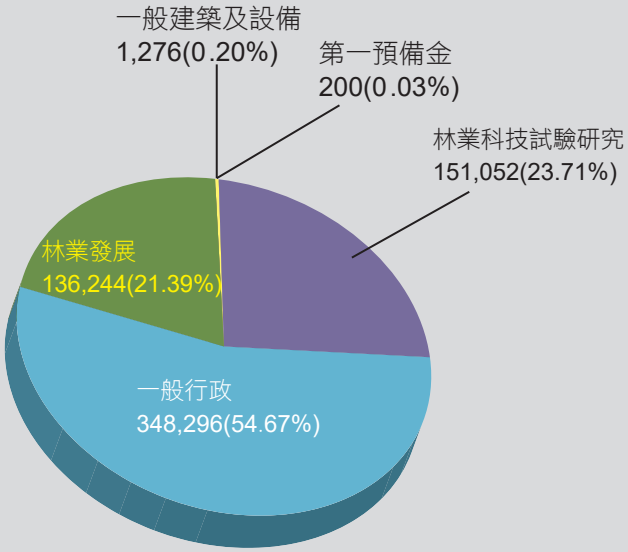
(二)105年度決算

1.歲入：本年度歲入預算數8,755千元，決算數12,079千元，執行率137.97%，其主要內容如圖3。

2.歲出：本年度可支用預算數637,068千元，決算數630,830千元，執行率99.02%，其主要內容如圖4。



▲ 圖3. 105年度歲入預算執行情形（單位：千元）



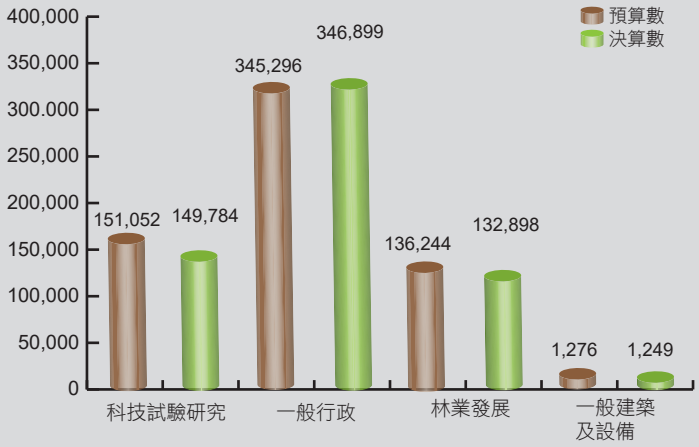
▲ 圖2. 105年度歲出預算主要內容（單位：千元）

(三)105年度科技部補助計畫經費

本年度辦理科技部補助計畫經費11,790千元，執行數9,432千元，執行率80.00%。

(四)105年度代辦計畫經費

本年度辦理代辦計畫經費37,624千元，執行數31,552千元，執行率83.86%。



▲ 圖4. 105年度歲出預算執行情形（單位：千元）

2016 Annual Report

行政院農業委員會
林業試驗所一〇五年度年報

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