Annual Report 2020

Taiwan Forestry Research Institute

行政院農業委員會林業試驗所

一〇九年度年報

序

2020年受新型冠狀病毒 COVID-19 疫情的爆發，衝擊全球經濟及人民的日常生活，各行各業在新冠疫情的延燒下，均有不同程度的影響；國際紙漿也因頻繁的野火造成原物料減少，導致價格逐漸上漲，並連帶影響相關產業；在疫情及物價上漲的雙重席捲下，全民的生活重心，除了基本生活維持所需，更多了對戶外開闊空間及自然環境的嚮往，在緊促的壓力下，尋覓身心靈的舒緩及療癒之所。

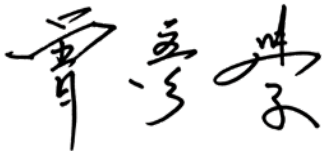
依據全國第四次森林資源調查的結果，臺灣面積有超過60%是森林，蓊蓊鬱鬱的森林孕育著多樣的動植物生態，加以特殊地理位置及地形，造就了不同的森林型態。森林具有多元效益與功能，除了經濟效益、生態效益還有其遊憩功能，各項資源與人民生活息息相關，如何妥善維繫這些森林資源，並善加規劃利用及永續經營管理，凸顯出林業研究工作之重要性。

林業試驗所成立歷史悠久，肩負臺灣森林試驗研究之責，所屬各單位都有其任務導向及角色定位，長期以來，致力於森林資源保育、造林撫育、林業經營與經濟、生態系與集水區經營、森林保護、森林生產及利用等專業領域的研究，並透過試驗、鑑定、諮詢及技術移轉等服務，加強研究成果與產業連結，與全民共享永續的自然資源。

本所在歷任所長的領導下均有佳績，近年研究成果包括林下經濟、國家植物園方舟計畫、木質廢料循環利用、樹木健康管理與都市林經營管理技術、推動里山產業發展與林園療癒等，未來除了延續歷任所長的施政方向，並將持續加強與各相關單位之橫向連結，精進本所各專業領域研究人員研發技術，透過持續監測調查與試驗，提出科學性的研究成果與驗證，輔助林業政策的推動，並隨社會環境的變動趨勢適時調整，以發展符合臺灣未來新林業之對策，充分發揮林業之生產、生活與生態功能。

本刊為本所同仁 2020 年研究成果的彙總，感謝同仁這一年的努力，也敬請各方不吝指正。

行政院農業委員會林業試驗所

所長  謹誌

2021年10月

Preface

In 2020, the onset of the COVID-19 pandemic deeply impacted the economy and the lives of people worldwide. Industries around the world have had to find new ways to cope with the threat of the virus. At the same time, the frequent occurrence of wildfires has also decimated the supply of pulp and caused an increase in its price on the global market. This has had a huge negative impact in many industries. With the threat of the pandemic and rising prices looming around us, citizens are finding themselves ever more drawn to the unbound openness offered by natural spaces. These places serve the important function of maintaining the physical and mental well-being of citizens.

According to the Fourth National Forest Resources Survey, more than 60% of Taiwan is covered in forests. These forests are the home to myriads of diverse and complex ecosystems; moreover, the island nation's varied geography and features have also created a multitude of different types of forests. Forests provide multiple benefits and functions ranging from the economical, biological, to the recreational, all of which are intimately related to the lives of the citizens. Forestry research, as result, is inherently important because it contributes to the proper maintenance, planning, and sustainable operation of these forestry resources.

The Taiwan Forestry Research Institute has a long history of contributing to the research of Taiwan's forests, with each division within the Institute serving specific goals and missions. Their tasks include: the preservation of forest resources, planting of forests, management of forest-based economies, management of ecosystems and catchment areas, conservation of forests, production and utilization of forest resources, research into specific academic disciplines, testing, appraisal, and consulting services, and transfer of technology. These tasks enhance industry-academia collaboration and its results, which help ensure the sustainability of forest resources for all.

The TFRI has been able to deliver exceptional results thanks to the leadership of each Director General. The Institute's research results in recent years include the under-forest economy initiative, national botanical garden projects, waste wood recycling, arboreal health management, urban forest management technology, Satoyama Initiative-based industry development, and forest healing, etc. In the future, we will continue to follow through with policy directives of past Director Generals, as well as continue to strengthen horizontal links of each subdivision to improve the research and development capabilities of the Institute. Through continuous monitoring, surveys, and experiments, the Institute will expand its academic contribution through both experimental and validated work to support the promotion of forestry policies in Taiwan. We seek to ensure the importance of forestry policies in Taiwan through constant adjustments to make the best use of the productive, ecological, and recreational capabilities of our nation's forests.

This publication represents the collated research efforts of the Taiwan Forestry Research Institute in 2020. I would like to take this opportunity to thank each and every one of our staff for their hard work this year. I sincerely welcome all of your suggestions.

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

October, 2021

Yonhsueh Tseng

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Introduction

前言

林業試驗所109年度實際在職人數為166人，歲入預算數10,282千元，較上年度減列300千元，歲出預算數799,933千元，較上年度增列 79,272千元。為利各界瞭解本所109年度施政概況，本刊援例以計畫領域為編纂軸心，刊載已結案之計畫成果70項，分作三類呈現：一、林業科技試驗研究計畫(含工作項目)57項(81.4%)。二、所外委辦計畫10項(14.3%)。三、科發基金及科技部補助專題研究計畫3項(4.3%)。除完成各類計畫外，109年度亦推動多項施政簡述如次：

一、永續林業生產試驗研究方面：

發展長期優質經濟人工林，擴大種子園生產，申請土肉桂品種權與技轉，發展牛樟分子標誌，發展林下經濟並建立4種模式示範區；發展符合森林認證原則之私有林人工林收穫模式，分析歷年林火趨勢與林火週期，完成臺灣樹種生長收穫模式資料庫；完成標準化都市樹木調查監測程序制定並建立珍貴老樹健檢技術平台；完成里山指標測試評估，並運用社會經濟指標與生態關注區域進行空間疊圖；持續建構木材AI樹種辨識系統；完成樹木健康與風險評估手冊編撰，影像分析六都都會區綠覆率，建立物候調查作業標準化流程。

二、試驗林生態系示範經營方面：

加強6處試驗林及2處自然保留區之試驗林經營管理，建立多元化育林體系，維護試驗林之完整性，強化作業研究及示範功能；改善並維護現有試驗林區林道品質；持續辦理森林生態系之示範經營與監測計畫，建立長期監測系統；持續辦理林業技術教育推廣，加強環境保護及解說、推廣教育場館、圖書館經營管理及推廣刊物出版；強化林業試驗資訊管理、資訊安全、研究資料倉儲、管理制度與技術諮詢服務。

三、植樹造林試驗監測方面：

持續蒐集與監測現有平地造林地生長與生態資料；利用平地造林疏伐與修枝小徑材開發文創產品及商品化研究；整合德國法正林與臺灣泰雅族傳統混農林生產系統，發展適用於平地造林的「法正混農林生產系統」；提供速生高纖樹種造林技術，建立短伐期經濟樹種經營示範區；進行造林地、毗鄰農地與混農林業病蟲害監測及林木健康管理；探討森林景觀現況與特性、評價與認知、景觀保護與活用策略等，並於平地森林園區規劃推動各類林園療育遊程活動。

四、國土生態保育綠色網絡建置計畫方面：

針對淺山及平原之農林生態系統，建立2 處示範地點，並推動里山地景變遷分析、里山指標評估、動植物多樣性探究、民族植物與傳統生態知識盤點等工作，使用航照疊圖分析，整合動物與植物資源分析成果提出調查及評估方法之手冊，並舉辦成果分享工作坊、兩地訪談及專家訪談；組織訓練社區居民，接續推動未來的動植物監測工作。建立不同生態系統傳統生態知識盤點標準作業規範。

五、國家植物園方舟計畫方面：

強化各既有植物園及相關苗圃溫室之物種培育能力，成為物種保存基地；掌握列屬於臺灣維管束植物紅皮書之物種(約989種)及其棲地分布，針對急迫保育需要的物種，優先推動種原收集與保存，減輕族群滅絕風險。109年度已新增170種受威脅物種之收集與保存，與108年度合計225種，保種率達49.7%，並結合國家植物園系統及協力單位，建立與自然保護區系統就地保育相輔相成之國家植物園遷地保育系統，提高森林生物之保種能力。

此外，本刊亦檢附109年度之重要記事、專題演講、出版品、技術移轉案件、發表報告、財務預決算、人力資源等訊息，謹供各界檢視本所當年度之整體施政成效。

Introduction

During 2020, the Taiwan Forestry Research Institute (TFRI) employed a total of 166 people, had an annual revenue of NT$10,282,000, which is NT$300,000 less than the previous year, and had an annual expense of NT$799,933,000, which is NT$79,272,000 more than the previous year. To facilitate the public's understanding of the Institute's governance results in 2020, this publication compiled 70 completed projects from the Institute and divided them into different fields of focus. The projects are divided into the three following categories: 1. Forestry technology research projects: (including work projects) 57 projects (81.4%). 2. Projects entrusted to external contractors: 10 projects (14.3%). 3. Projects funded through the Science and Technology Development Fund and other special research projects sponsored by the Ministry of Science and Technology: 3 projects (4.3%). Besides the above-mentioned projects, the Institute has also produced the following results during 2020:

I. Sustainable Forestry Resource Production Research:

The TFRI invested into the development of long-term and high-quality economic forest plantations, expanded seed orchard production, applied to acquire native cinnamon species rights and the subsequent technology transfer, developed stout camphor tree molecular markers, worked towards the development of a forest-based economy, and established four separate model demonstration areas; developed a Forest Stewardship Council-approved harvest model for privately owned forests and man-made forests, analyzed historic wildfire trends and cycles, completed the growth and pattern database for native Taiwanese tree species; deployed a standardized urban tree survey and monitoring process, and established a health check-up platform for valuable old trees; Completed the testing and assessment for the Satoyama Initiative indicators, as well as the construction of an overlay map using social economic indicators and key ecosystem areas; continued the deployment of an AI-based tree and wood material identification system; completed the compilation process of a tree health and risk assessment manual, image analysis of the green coverage ratio of the six major metropolitan cities in Taiwan, and deployment of a standardized phenological investigation process.

II. Management of Experimental Forests:

The TFRI improved upon its management process of six different experimental forests and two experimental forests in natural reserve areas to establish a diversified forestry system, maintain the integrity of the experimental forests, and improve their research and experimental capabilities; maintained and improved the existing forest walkways in experimental forests; continued the management and monitoring efforts of ecosystems in experimental forests and established a long-term monitoring system; continued the promotion of forestry technology education, enhanced forest protection education, promoted its educational venues, and improved the management of relevant library materials and publication of related press articles; enhanced the information management, information security, research data storage, management system, and technical consultation services of forestry experiments.

III. Research and Monitoring of Afforestation Efforts:

The TFRI is dedicated to the continued collection and monitoring of existing afforestation efforts in flatlands and related ecosystem data; researched the commercialization and souvenir possibilities using flatland afforestation thinning and branch trimming materials; integrated the concept of normal forest, which originated

in Germany, with traditional Atayal hybrid farm-forests to create a "Normal Forest-Atayal Hybrid Forest Production System"; provided fast-growing high-fiber tree planting techniques to establish demonstration areas for short rotation forestry crop trees; managed and monitored the health and pest status of afforested lands, nearby farmland, and hybrid forests; investigated the state, characteristics, assessment, public awareness of current forest sceneries for conservation or utilization purposes, and implemented various forest-based leisure activities in flatland forest areas.

IV. Implementation of the National Ecology Green Network Establishment Project:

The TFRI has established two demonstration conservation sites for forests in low-elevation mountain and flatland areas. The sites serve as a venue to promote the analysis of the geographical changes of the Satoyama landscape, assessment of Satoyama Initiative indicators, exploration of animal and plant biodiversity, and inventory process of traditional plants and ecological know-hows. The Institute's staff analyzed aerial overlay maps to integrate animal and plant resource distribution of the area and compiled a manual detailing the investigation and assessment process of their work. This manual was eventually showcased in a workshop alongside expert and bilateral interviews. In the process, the TFRI also trained local residents to continue the monitoring efforts of local biodiversity in the future. The TFRI also implemented a standard of operation procedure for the knowledge inventory process of traditional ecological know-hows in various ecosystems.

V. Implementation of the National Botanical Garden Project:

The TFRI seeks to strengthen the botanical nurturing capabilities of botanical gardens and seedling greenhouse institutions in Taiwan to transform them into preservation bases for various species. Currently, the Institute has collated a total of 989 plants from the *Red List of Vascular Plants of Taiwan*, and plotted their distribution. It has prioritized the collection and preservation of critically endangered species to mitigate the possibility of extinction. In 2020, 170 endangered species were collected and preserved, totaling 225 species including those collected during 2019 to reach a coverage rate of 49.7%. The Institute is also working with the National Botanical Garden system and other units to establish a National Botanical Garden ex situ conservation system that complements the in situ conservation efforts of the nature reserve system to improve its overall conservation capacity of forest organisms.

Lastly, this publication includes an index of important events, academic speeches, completed publications, technology transfers, published reports, financial reports, and HR information of the TFRI during 2020 as a means for the public to better examine the Institute's governance results of the year.

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研究計畫推動及成果

Development and Results of Research Projects

不同農法及周邊地景對水稻田有螫類群集影響之研究

陸聲山、葉文琪、林依靜、宋一鑫

蜂是昆蟲綱(Insecta)膜翅目(Hymenoptera) 昆蟲的簡稱，許多種類常被視為有用昆蟲。比如寄生性與捕食性的蜂能應用在生物防治，而訪花的蜂則能應用在植物授粉。捕食性的狩獵蜂(hunting wasps)與訪花性的花蜂(bees)，其雌蜂具產卵管，多數形成螫針，屬於有螫類群 (Aculeata)。本研究於2020 年2-6 月間，利用高屏地區第一期稻作期間，架設誘引巢體進行定量密集調查。共選取美濃(MN)、大寮(DL)、旗山(CS)、萬丹(WD)等四處的田區，總共4 個永續與4 個慣行農法樣區。誘引巢體的調查結果，僅在大寮慣行田及美濃慣行田收到1 種亮胸切葉蜂(*Megachile igniscopata*) 38隻，其中大寮慣行田共計收到亮胸切葉蜂雌蜂19 隻，雄蜂18 隻；美濃慣行田僅收到1 隻雌蜂。而大寮永續田發現黃柄壁泥蜂(*Sceliphron madraspatanum formosanum*)築巢於誘引巢體的外壁上，利用鐵蓋下較遮蔽之處築巢，共收到6 隻黃柄壁泥蜂。因誘集的資料量非常有限，未能進一步進行相關分析。此外，於4-6 月間利用掃網法於旗山及美濃的田區周遭補充採集，共採集到有螫蜂9 科16 種，包括蜜蜂科(Apidae)、分舌蜂科(Colletidae)、銀口蜂科(Crabronidae)、隧蜂科(Halictidae)、切葉蜂科(Megachilidae)、蛛蜂科(Pompilidae)、土蜂科(Scoliidae)、細腰蜂科(Sphecidae)、胡蜂科(Vespidae)。與2019年宜蘭利用黃盤補充採集捕獲的9 科21 種，顯示田間周遭仍有多種不同的有螫蜂類。其中隧蜂科的*Lipotriches ceratina*，於高屏地區水稻田開花時出現大量個體採集花粉，是之前苗栗、宜蘭水稻田未記錄到的種類。根據國外研究*L. ceratina* 為水稻田常見授粉蜂，在旗山及美濃田區亦為數量眾多的常見種類。本結果建立水稻田及周遭生態系有螫蜂類的多樣性，以做為未來探討其生態功能、物種間相互作用，或是評估作為棲地品質生物指標的基礎資料。

隧蜂科的*Lipotriches ceratina*，左雄右雌。
Lipotriches ceratina belong to the Family Halictidae, left male and right female.

The influences of different farming systems and landscapes on the community of aculeate Hymenoptera

Sheng-Shan Lu, Wen-Chi Yeh, Yi-Ching Lin, I-Hsin Sung

The aculeate wasps and bees are beneficial insects for biological control and/or pollination services. Some of the aculeate wasps and bees may use either existing cavities or man-made holes to construct their own nests, and were called trap-nesting wasps and bees. Two plots managed by different farming system (sustainable vs. conventional) were selected from each of four sites (Meinong, Dalaio, Cishan, Wandan) in Kaohsiung and Pingtung Counties and four trap nests were setup at each of the eight plots from late February to June 2020. According to the results of the trap-nesting wasps and bees of rice fields in 4 areas of Kaohsiung and Pingtung counties, only one species of *Megachile igniscopata* was collected in the Daliao and Meinong conventional agricultural fields. There were total 38 individuals of *M. igniscopata*, including 19 female and 18 male were collected at the Daliao conventional field, and only 1 female *M. igniscopata* was collected in Meinong conventional field. It was found that *Sceliphron madraspatanum formosanum* was nesting on the outer side of the trap nest at the sustainable field of Daliao, and the nest was built in a sheltered place under the iron cover. A total of 6 *S. madraspatanum formosanum* were collected. Because limited data of trap-nesting this year, no further analysis can be carried out. In addition, from April to June, the sweeping method was used to supplement collections around the fields of Cishan and Meinong. A total of 16 species of aculeate wasps and bees were collected from 9 families, including Apidae, Colletidae, Crabronidae, Halictidae, Megachilidae, Pompilidae, Scoliidae, Sphecidae, Vespidae. Compared with the 9 families and 21 species collected at Yilan County in 2019, indicating that there are still many aculeate wasps and bees around the rice field. Among them, *Lipotriches ceratina*, a species of the family Halictidae, has a large number of individuals collecting pollen when the rice blooms in the rice fields of Kaohsiung and Pingtung areas. *Lipotriches ceratina* is a species not previously recorded in the rice fields of Miaoli and Yilan. According to foreign research, *L. ceratina* is a common pollinator in rice fields, and it is a common and abundance species in Cishan and Meinong areas. This result establishes the diversity of aculeate wasps and bees in rice fields and the surrounding ecosystems, which can be used as basic data for future exploration of their ecological functions, interactions between species, or assessment of habitat quality biological indicators.

亮胸切葉蜂
Megachile igniscopata

經由口述歷史訪談探索台灣林業女性研究人員在森林科學及林業經營發展的貢獻

張勵婉、王培蓉、王巧萍

工作中兩性性別的均等，可有效率的解決不同的問題，更有利於促進創新。有鑑於性別議題在國際林業研究發展上日益重要，國際森林聯合大會(IUFRO) 2000年特別成立了性別與林業(Gender and Forestry)的專門研究組；近十多年來有許多研究，探討男性與女性不同性別之林業工作人員在森林經營、資源利用以及森林工作類型選擇中，各面向的差異及所發揮的效用。而台灣林業與性別的研究則非常稀少，對於利用口述歷史方法，對於女性從業人員進行訪談更是闕如。本研究經由口述歷史方法，訪談5位女性研究人員、1位女性行政人員，瞭解個人家庭教育、成長背景，及從事林業相關工作的職涯歷程，包含為何選擇就讀森林科系，以及所從事的林業研究/行政相關工作、遇到的困難、阻礙性別歧視以及克服困難的策略。進而探討女性林業從業人員之研究或行政經歷，對於台灣林業科學或林業經營發展的貢獻。計畫成果除可提供年輕世代了解過去女性林業研究人員的貢獻外，並可作為欲從事林業研究工作女性之職涯規劃參考。

訪談劉瓊蓮女士。
Interviewing with Ms. Liu Qionglian.

Exploring the contribution of Taiwan female forestry researchers in forest science and forestry management development through oral history

Chang Li-Wan, Wang Pei-jung,Wang Chiao-Ping

Gender equality in work, can be an effective solution to different problems, and more conducive to promoting innovation. Due to the growing importance of gender issues in international forestry development, The International Union of Forest Research Organizations (IUFRO) established a special research group on gender and forestry in 2000. Over the past 20 years, a number of studies have examined different genders in managing forest, utilizing resource, and selecting of forestry work types and the differences between the various aspects and the effectiveness. However, there are few studies on forestry and gender in Taiwan, especially the use of oral history and the interview of female practitioners. In this study, 5 female researchers and 1 female executive were interviewed by oral history method to understand personal family education, growth background and career history of forestry related work, i.e. how they chose their research project, how they overcome unfair treatments in their research career. Furthermore, the research or administrative experience of female forestry practitioners and their contribution to the development of forestry science or management are also discussed. The research provides young generations with information about the contribution of female forestry researchers to forestry in the past and can provide career planning information for women who wish to do the forestry research work.

臺東南迴線刺軸含羞木調查及防除監測計畫

賴政徽

刺軸含羞木(*Mimosa pigra* L.)自1997年在臺灣南部發現以來快速蔓延屏東、高雄、臺南、以及臺東等地區，在東部地區主要分布於臺東縣達仁鄉及大武鄉一帶，近年來為防範擴散，林務局臺東林區管理處採取積極的移除作業，2019年於雨季前(4月上旬)及開花期間(6月下旬)皆以機械整治方式由朝庸溪出海口開始向中游及上游進行機械防治作業，移除後於初期目視移除效果甚佳，但僅能維持約1個月即可發現萌蘗芽體及實生小苗再次覆蓋移除範圍，且刈草後萌蘗枝條可於30天內生長超過40 cm。

其生長環境多為溪床兩岸、道路旁、廢耕農田、河川出海口及溪流之人造構造物周圍(如攔沙壩、集水井等)，依分布點位之土地利用型推論其傳播方式及路徑與人為活動關係密切。刺軸含羞木除於溪床及出海口形成大片純林之外，亦可與其他草類及蔓藤類植物伴生不受影響。

監測結果發現刺軸含羞木可維持四季開花，僅受季風影響區域有枝葉乾枯現象。機械防治作業後每平方公尺平均可發現6.35株萌發小苗，人工刈草後40日左右，萌蘗平均高度可達40 cm以上，且可觀察到開花情形；顯示單一防治作業成效有限。依據上開監測及調查成果來設計整合型機動性防治策略，以機械整治配合人力防除並搭配持續監測；並用預防、早期偵測、滅除、控制等四主軸擬定臺東地區刺軸含羞木預防及管理計畫，提供未來防治工作及管理方式之參考。

刺軸含羞木已入侵臺東南迴地區，應積極採取防治作為。
Mimosa Pigra L. has invaded the Taitung south bound area , we should take preventive actions actively.

The distribution, prevention, and monitoring of *Mimosa Pigra* L.in Taitung south bound area

Cheng-Hui Lai

As Mimosa pigra L. was found in south Taiwan in 1997, it spread rapidly from Pingtung , Kaohsiung and Tainan to Taitung. The main distribution range in Taitung is Daren Township and Dawu Township. The Taitung Forest District Office of the Forestry Bureau took a serious measure to prevent the proliferation. The mechanical preventions were taken from the midstream to the estuary of Chaoyongxi during April (before rainy season) to June (flowering period). The visual effect was fine in the beginning, but the sprouting and seedling has covered up the whole area after 1 month. And the sprout branches would grow over 40 cm.

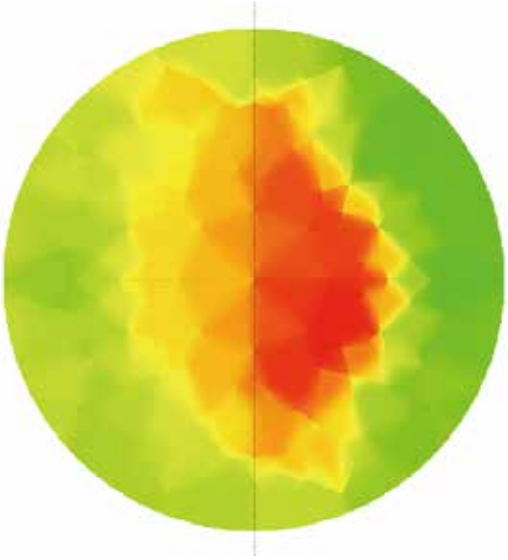
The common habitats of Mimosa pigra L. are the river banks, the roadsides, set-aside lands, the river estuaries, and hydraulic structures (ex: sand bar and water catchment well). The dissemination may be related to human activities by inferencing the distribution points and the land uses. Mimosa pigra L would easily form a pure stand on the riverbed and the estuary, it could also grow with other grasses and vines.

The phenology of *Mimosa pigra* L. is that it could continue to bloom all year round. The leaves would become wither only affect by the Northeast monsoon. When monitoring on the mechanical removal, 6.35 sprouts were found per square meters. The branches would grow over 40 cm after 40 days by artificial mowing and the flowering were observed simultaneously. It shows that single way of prevention and control doesn't work so well. The integrated way of prevention and control based on the results of monitoring would be drafted by combining both mechanical and artificial methods. Also the prevention and management plan of Mimosa pigra L. in Taitung would follow the four spindles of prevention, early detection, eradication and control, to provide a decision-making reference in the future.

台南市行道樹樹木健全性研究

林振榮、林柏亨、廖和順

本計畫以應力波非破壞性技術(NDT法)共檢測413株樹木樹幹橫斷面的木材，將樹木危險等級區分成4個等級，其中危險等級為3等有12株，危險等級為4等有1株，其餘為1、2等級。由於樹木鄰接行人及車輛通道，如果樹木發生破壞傾倒，可能會有較高機率，並造成較嚴重後果的公共安全事件，所以優先針對風險較高的樹木先處理及列管，危險等級為4等樹木建議在適當時機採取安全性的移除作業；危險等級為3等樹木，建議樹木先予以標示，作為日後樹木內部木材是否繼續劣化的長期監測工作(定期檢查檢測)，並實施採取減緩風險等級的措施，如適當的修剪作業，以減輕樹體重量及風阻，降低樹木危險及風險等級。危險等級為2等樹木，建議樹木按照正規一般性的維護作業，並需要標示列管定期(年)追蹤觀察；危險等級為1等樹木，為正常樹木狀況，建議樹木按照正規一般性的維護作業，其餘請參考按照樹木風險管理規範進行。



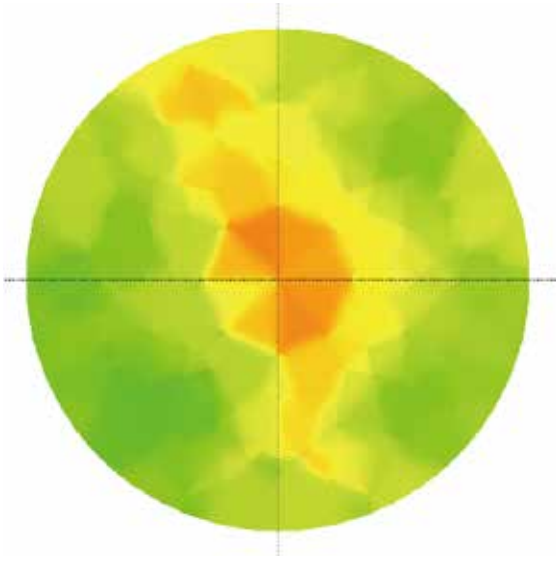
應力波速2D圖(1735-2577 m/sec)。
Stress wave velocity (1735-2577 m/sec).

樹木外觀可見光照片(第37號樹木)。
Tree appearance photo (Tree no. 37).

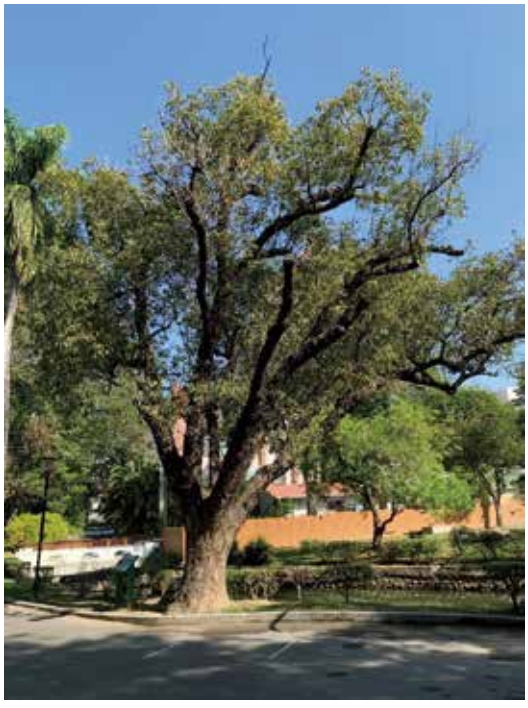
Study on the soundness of roadside trees in Tainan city

Cheng-Jung Lin, Po-Heng Lin, Ho-Shun Liao

This project uses stress wave non-destructive technology (NDT method) to detect the timber of 413 tree trunk cross-sections, and divides the tree hazard levels into 4 levels. Among them, there are 12 trees with a hazard level of 3 and a hazard level of 4. There is 1 plant, and the rest are grades 1 and 2. Since trees are adjacent to pedestrian and vehicular passages, if the trees are damaged and dumped, there may be a higher probability and cause more serious public safety incidents. Therefore, priority is given to the higher-risk trees to be processed and managed first, and the danger level is 4 Trees are recommended to take safe removal operations at an appropriate time; trees with a hazard level of 3 are recommended to be marked first as a long-term monitoring work (regular inspection and testing) of whether the wood inside the tree continues to deteriorate in the future, and implement the risk reduction level measures, such as proper pruning operations to reduce tree weight and wind resistance, and reduce tree hazards and risk levels. Trees with a hazard level of 2 are recommended to follow regular and general maintenance operations and need to be marked for regular (annual) follow-up observation; trees with a hazard level of 1 are normal tree conditions, and trees are recommended to follow regular and general maintenance operations, The rest please refer to follow the tree risk management regulations.



應力波速2D圖(1908-2430 m/sec)。
Stress wave velocity (1908-2430 m/sec).



樹木外觀可見光照片(第39號樹木)。
Tree appearance photo (Tree no. 39).

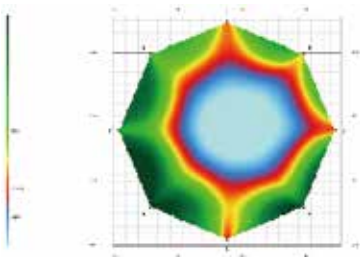
109年中正紀念堂定期樹木健全性研究

Regular Tree Soundness Inspection of Chiang Kai-shek Memorial Hall in 2020

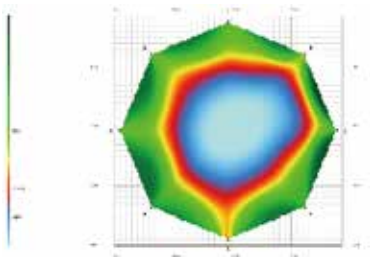
林振榮、林柏亨、廖和順
Cheng-Jung Lin, Po-Heng Lin, Ho-Shun Liao

本計畫共完成目視檢查686株，包含今年重點項目之南洋杉576株、樟樹56株及松樹類54株，目視主要檢視樹木結構性危險缺點，如腐朽空洞、傾斜、破裂、根系裸露、根部破裂(除草機傷害)、土壤壓實等，會造成樹基部腐朽，根部生長不良，樹木生長勢不佳等情形。目視檢查及應力波2D檢測樹木的結果，部分樹木有結構性的危險問題，惟風險尚低，建議持續追蹤，其中有2株樹木已達最危險等級(第4等級)，有發生傾倒的危險或損害的可能，建議最優先處理。列入第2-3等級的危險樹木，建議列入長期管理監測，視樹木生長狀況再處理(管理)，另外四周沒有遮蔽的暴露樹木，或風衝地帶的樹木，也應注意防範。最後請注意園區中有白蟻危害樹木的現象。

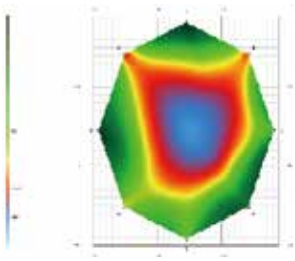
In this project, a total of 686 visual inspections have been completed, including 576 araucaria, 56 camphor trees and 54 pines, which are the key projects of this year. The visual inspection mainly inspects the structural hazards and defects of the trees, such as decay, cavities, tilt, cracks, bare roots, and roots. Cracking (weeder damage), soil compaction, etc., will cause tree base decay, poor root growth, and poor tree growth. As a result of visual inspection and 2D stress wave detection of trees, some trees have structural hazards, but the risk is still low. It is recommended to keep track of them. Among them, 2 trees have reached the most dangerous level (level 4) and are in danger of dumping. Or the possibility of damage, it is recommended to deal with the highest priority. Dangerous trees listed in the 2-3 level are recommended to be included in long-term management monitoring, and then processed (managed) according to the growth status of the trees. In addition, exposed trees that are not covered around or trees in wind-washed areas should also be taken precautions. Finally, please pay attention to the phenomenon of termites harming trees in the park.



樹木第64號(761-1555 m/sec)。
Tree no. 64(761-1555 m/sec).



樹木第193號(550-1197 m/sec)。
Tree no. 91 (550-1197 m/sec).



樹木第193號(715-1140 m/sec,)。
Tree no. 193 (715-1140 m/sec).

樹幹橫斷面應力波速2D圖。
Stress wave velocity 2D diagram in cross section of tree trunk.

夢幻湖水生植物復育暨展示計畫

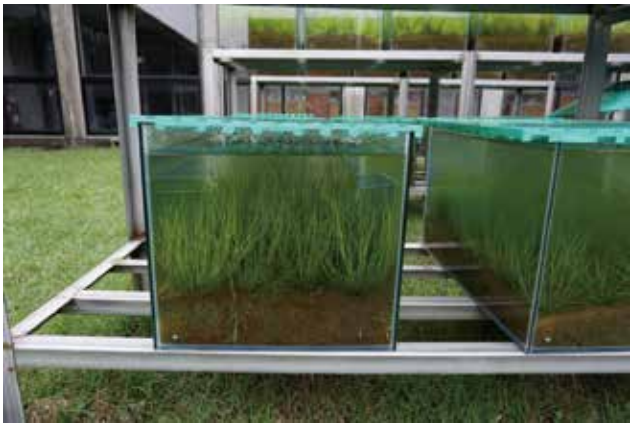
Aquatic plant restoration and exhibition of Menghuan Pond

黃曜謀
Yao-Moan Huang

臺灣水韭長期受到國人關注，為呈現現階段臺灣水韭保育研究成果，增進國人對臺灣水韭保育略及環境教育推廣之認同。本計畫執行下列5項內容：1.設立「夢幻湖水生植物生態缸」，供民眾近距離觀察臺灣水韭形態特徵、生長習性與水生植物生態。2.建立不同水位變化實驗池，讓遊客觀察水位對臺灣水韭生長之影響。3.辦理「認識夢幻湖水生植物」校外教學活動，讓教師和學生能夠將課堂所學與實際觀察做一連結。4.辦理志工培訓，讓志工瞭解夢幻湖生態環境、臺灣水韭形態特徵與生長習性。5.建構臺灣水韭繁殖中心。

Isoetes taiwanensis has long attracted the attention. In order to present the conservational results of *Isoetes taiwanensis* at this stage, and to enhance the recognition of the people on the conservation strategy and environmental education. Thus, this project carried out below 5 implementations. 1. Set up "Aquatic Plant Ecological Tank of Menghuan Pond" for the public to observe the morphological characteristics, growth habits and the aquatic plant ecology at closer distance. 2. Set up different water level change experimental pools, allowing visitors to observe the impact of water level on the growth of *Isoetes taiwanensis*. 3. Organize the off-campus teaching activities of "Knowing the Aquatic Plants of Menghuan Pond ", so that teachers and students can connect what they have learned in class with actual observations. 4. Provide volunteer training for understanding the ecological environment of the Menghuan Pond, the morphological characteristics and growth habits of *Isoetes taiwanensis*, and assist the management unit to maintain the ecological tank and the experimental pool. 5. Construct the nursery ground of *Isoetes taiwanensis*.

小學生們聚精會神栽植臺灣水韭。
Primary school students concentrate on planting *Isoetes taiwanensis*.



臺灣水韭繁殖中心。
The nursery ground of *Isoetes taiwanensis*.

2019年台日油茶栽培利用暨木本植物育苗技術研討會

謝靜敏

本所為提昇我國造林育苗作業技術，於108年12月4日辦理研討會邀請臺日育苗專家進行省工智慧之輔助器械，以提升農業生產力技術分享，另外亦協助成立南投縣特用作物18班並引入紙筒自動填土機組。

總統蔡英文在2016年時宣示台灣要走向循環經濟時代，將廢棄物轉換為再生資源，更是政府「5加2產業創新」政策之一，林業試驗所回應新農業與循環經濟面向，建置原鄉油茶生態高效治理典範朝向多元農業發展，從油茶資源應用與生態服務系統，利用創新技術配置原鄉資源生活圈，改善人民居住品質暨綠循環利用策略，打造具備環境風險韌性的永續安居生活空間。

本計畫所舉辦的油茶研討會是行政院原住民族委員會補助「財團法人台灣原住民部落振興文教基金會」，首次與林業試驗所合作，整合跨部會的優勢，於南投及臺北精心規劃為期一週的系列活動。11月28日南投場實機示範首先起跑，以南投仁愛鄉南豐村東岸部落生態教育園區為中心，展示原住民族代耕隊與區域鏈結、引入日本自動化育苗的經驗與示範區的經營，最後於12月4日再將部落的體驗與感動帶回臺北場研討會，邀請臺日專家介紹油茶產業最新技術，並以社區整體營造及生態學的觀點，分享學術研究的成果。

南投特作18班紙筒自動填土實機示範。
Demonstration of the automatic earth filling machine for the Paperpot at 18th forest compartment for special crops in Nantou County.

日本甜菜製糖株式會社紙筒事業部寺澤秀和部長(右三)應邀來台分享蜂巢式紙筒於日本使用現況。
Mr. Hidemikazu Terazawa (third from the right), the head of the Paperpot department of Nippon Beet Sugar Manufacturing Co., Ltd., was invited to Taiwan to share the current use of the Paperpot in Japan.

2019 Taiwan- Japan Technical Seminar on the Cultivation and Utilization of Tea Seed Oil and Woody Plant Nurseries

Ching-Ming Hsieh

To enhance the technology of forestry nursery operations in Taiwan, Taiwan, the Taiwan Forestry Research Institute (TFRI) held a seminar on December 4, 2019 and invited Taiwanese and Japanese nursery experts to discuss labor-saving and intelligent auxiliary equipment that increases agricultural productivity and technology sharing. TFRI also assisted in the establishment of the Nantou County Special Crops Cooperative No.18 and introduce an automatic Paperpot filling machine.

In 2016, President Tsai Ing-wen declared that Taiwan would move towards the era of circular economy, especially the conversion of waste into renewable resources, which is a part of the government's "5 + 2 Industrial Transformation Plan." Therefore, the TFRI has responded to the call for "new agriculture" and the development of a circular economy by establishing a model of ecological and efficient management of tea seed oil (camellia oil) plantations in indigenous communities and promoting advancements towards diversified agricultural development. With the application of tea seed oil resources and ecological service system, innovative technology is utilized to configure the lifecycle of indigenous resources, thus improving the quality of life and bolstering the circular strategy of green renewable resources and creating a sustainable living space with resilience towards environmental risks.

This seminar on tea seed oil cultivation is the first joint collaboration between TFRI and the Taiwan Indigenous Tribes Culture and Education Rejuvenation Foundation (TITCERF), which is a non-profit organization subsidized by the Council of Indigenous Peoples of the Executive Yuan. This project fully leveraged the advantages of inter-ministerial collaboration and integration, which culminated in a week-long series of activities in Nantou and Taipei. On November 28th, the Nantou demonstration event kicked off, centering on the Alang Tongan Tribal Ecological Education Park in Nanfeng Village, Renai Township, Nantou County to showcase the indigenous people's substitute farming team and regional linkages, the introduction of Japan's experience in automated seedling cultivation and the operation of a demonstration zone. Later, on December 4th, the experiences and inspirations from the tribal demonstration zone were brought back to the main seminar in Taipei. Taiwanese and Japanese experts were invited to introduce and have an exchange on the latest technological developments in the tea seed oil industry and share the results of academic research from the perspective of overall community building and ecology.

木材供需調查及其需求模式建立與預測之研究(1/2)

林俊成

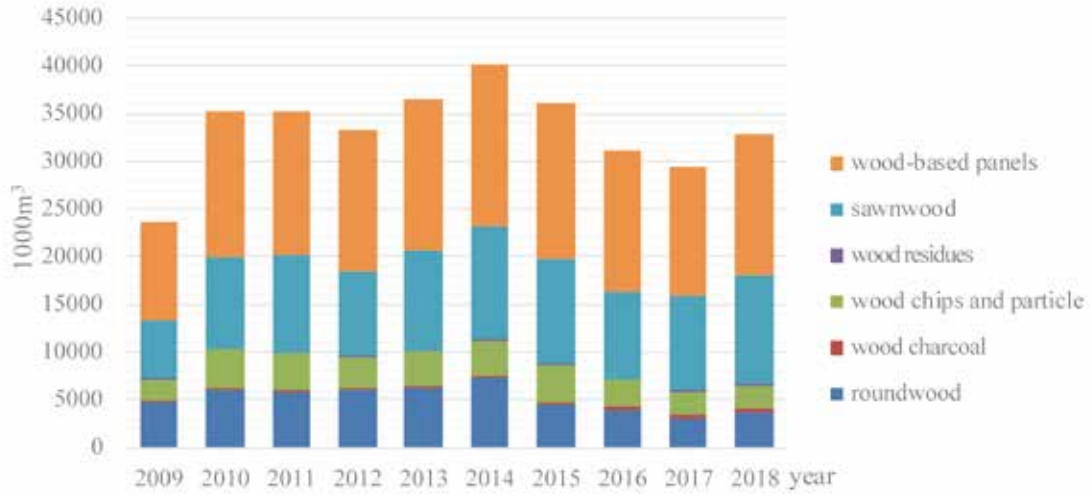
本計畫共完成三項計畫目標，第一建立符合國際分類標準之木材與林產品量質統計資料推估模式。首先依據FAO分類，分析2009-2018年實木產品包括原木、木炭、木片及粒片、木材殘餘物(其他木片)(樹皮,鋸屑)、製材、木質人造板等6類之進出口數量與價值。其次根據國內相關公會引介各類產品主要進口商做為調查對象，調查各類產品進口流向，採用建立符合國際分類標準之木材與林產品量質統計資料推估模式。第二在分析私有林潛在木材供給區位及生產潛力。本計畫利用第四次森林資源調查公布之「生產性人工林」及「平地造林」範圍為基礎，扣除不宜伐採區域及篩選位於道路1000公尺範圍內後，屬於林地之具生產性人工林面積共約10.5萬公頃，其中私有林約3.3萬公頃，林務局租地1.4萬公頃，並主要分布於苗栗縣、南投縣及新竹縣，為短期進行林木生產之重點潛力區位。第三，評估增列林業生產目標指標之可行模式。本計畫比較2015年度林業普查與林業統計於林業產值上的差異，結果發現林業普查的林業收入約5.8億元，同年度林業統計之林業產值約2.4億元，兩項調查資料在副產品方面差異甚大，兩者的資料除收入金額不同外，在林業家數的資料方面也有所不同。

2009-2018年臺灣實木林產品進口數量。
2009-2018 Imported quantity of Taiwan's solid wood forest products.

Research on Domestic Wood Supply and Demand Investigation and Stable Supply Mechanism Planning(1/2)

Jiunn-Cheng Lin

This project has 3 goals this year, the first is to establish a model for estimating the quantity and value of timber and forest products that meet international classification standards. This study analyzes the import and export quantity and value of 6 types of solid wood products including roundwood, wood charcoal, wood chips and particles, wood residues (other wood chips) (bark, sawdust), sawnwood, and wood-based panels from 2009 to 2018 that is in accordance with the FAO classification. The main importers of various products were introduced by relevant domestic associations as research objects to investigate the import flow of various products, and the estimation model of the quantity and quality of timber and forest products conforming to the international classification standards is adopted. Secondly, in terms of potential wood supply location and analysis of production potential of private forests, this project uses the "productive plantation" and "flat land afforestation" ranges announced by the 4th Forest Resources Survey, after deducting the unsuitable logging range and screening within 1000 meters of the road, the productive plantation forest area of the forest land is about 105,000 hectares. Among them, there are about 33,000 hectares of private forests and 14,000 hectares of land leased by the Forestry Bureau. They are mainly distributed in Miaoli County, Nantou County and Hsinchu County, and they are key potential areas for short-term forest production. Finally, in terms of evaluating the feasible models for adding additional forestry production target indicators, this project compares the difference between the forestry census and forestry statistics in the forestry output value in 2015. The result shows that the forestry income of the forestry census is about 580 million TWD, and the forestry output value of the forestry statistics of the same year is about 240 million TWD. The two survey data are very different in terms of by-products. In addition to the different amounts of income, the census and statistics data also differs in the information on the number of forestry households.



2009-2018年臺灣實木林產品進口數量。
2009-2018 Imported quantity of Taiwan's solid wood forest products.

108年度褐根病診斷鑑定研究暨防治教育推廣研討會講習班辦理

吳孟玲、徐孟豪、劉則言、莊鈴木、張東柱、傅春旭

本計畫執行期間為108年5月至109年5月，擬整合國內褐根病防治資源，有效減少國內樹木褐根病感染與蔓延情形，並擬透過褐根病分級通報流程之建立，讓民眾在處理罹染褐根病樹木時由所依循，並藉此準確了解國內各地方褐根病擴散與蔓延情形，並提供相對應的防治對策。計畫內容包括防治褐根病教育訓練、褐根病之樣本診斷鑑定檢測服務、防治管理宣導及實務示範、建立褐根病害分級通報及防治機制與即時智慧化褐根病檢測技術之評估與研發等工作項目，工作重點如下：樹木褐根病及重要樹木病蟲害講習班暨研討會共4場；提供褐根病病菌快篩診斷技術服務500件；受理「褐根病」案件通報及防治服務；褐根病防治諮詢服務、建立分級通報與防治管理流程，進行褐根病害分級檢測研究，配合計畫執行面臨之病害分級通報與管理之需求，研擬相互搭配的褐根病害快速檢測技術與分級防治管理；褐根病菌即時檢測技術發展及強化分子檢測技術流程研究。提供地方褐根病防治策略，給予第一線人員技術資訊支援，期能逐步控制全國褐根病疫情，全國 共同防治褐根病。

關鍵詞：褐根病、診斷鑑定、防治管理

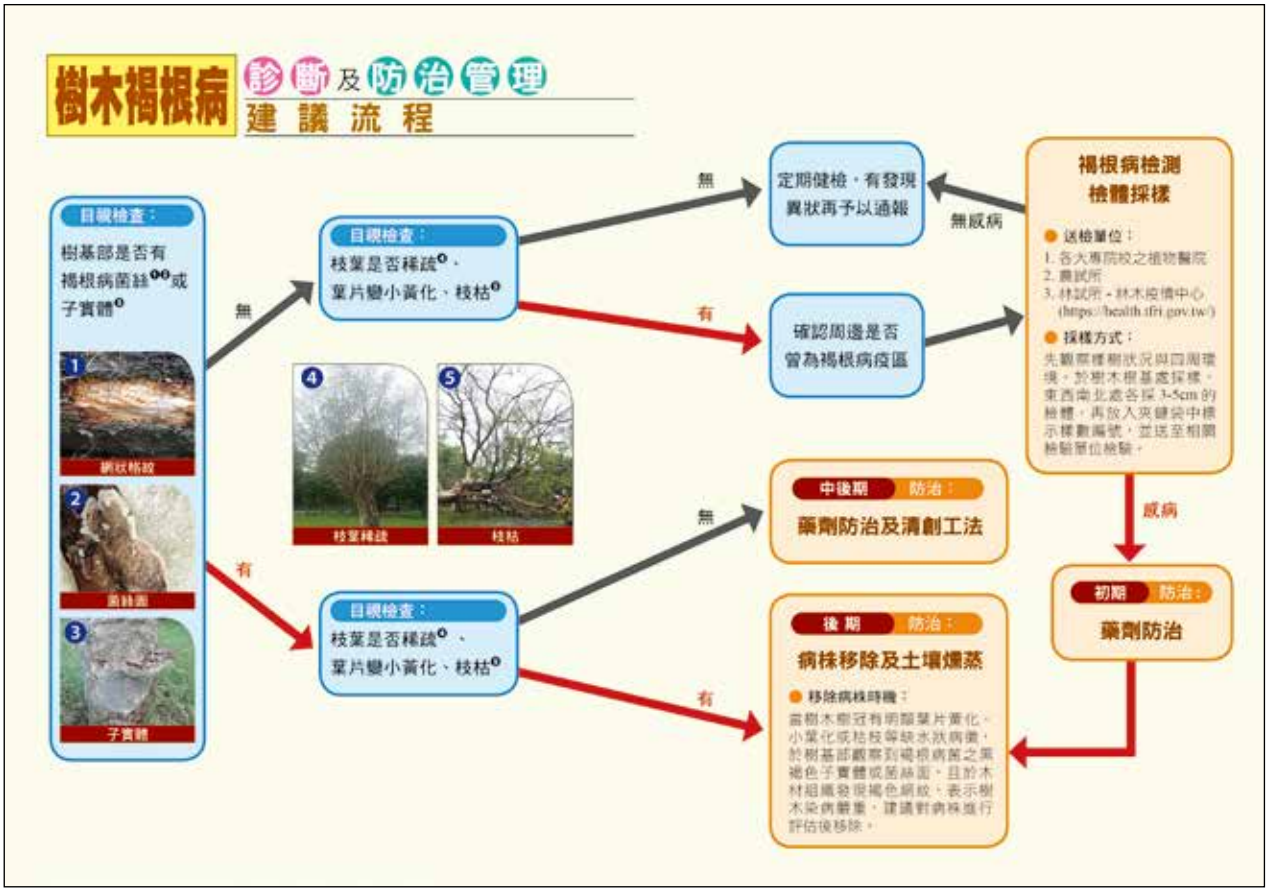
108年度於林業試驗所舉辦的褐根病研討會講者合影)。
A group photo of speakers at the Brown Root Disease Seminar held at Taiwan Forestry Research Institute in 2019.

Brown root disease diagnosis and identification research and prevention education promotion seminars in 2019

Meng-Ling Wu, Meng-Hao Hsu, Tse-Yen Liu, Lin-Mu Jaung, Tun-Tschu Chang, Chuen-Hsu Fu

The project was conducted from May, 2019 to May, 2020 and managed to integrate prevention and control resources for brown root disease to effectively reduce its spread in domestic trees. It also established a classification notification system for brown root disease based on the severity of the infected trees to allow the authorities to decide what are the following measures should be applied. In this way, we can accurately understand the spread of brown root disease in various places in the country, and provide corresponding control measures. This study included education and training on prevention and treatment of brown root disease, services of diagnostic testing for sampled brown roots, prevention and management promotion and practical demonstration, establishment of brown root disease classification notification and prevention mechanism, and evaluation and development of immediately intelligent brown root disease detection technology, etc. In this study, we also accomplished following works: a total of 4 workshops and seminars on brown root diseases and important tree pests and diseases, 500 pieces of technical services for rapid screening and diagnosis of brown root disease bacteria, notification and prevention services of brown root disease cases, consult services for the prevention and control of brown root disease, establishment of hierarchical notification and control management procedures. The molecular real-time detection technology was developed to strengthen rapid diagnosis for brown root disease. In this way, above-mentioned combination measures can provide the local authorities or operators for management of the disease with enough technical information support and control strategies. Finally, the brown root disease can hopefully be effectively controlled.

Key Words: brown root rot disease, diagnostic identification, Prevention and management



樹木褐根病診斷及防治建議流程圖。

Process chart for diagnosis and prevention and control of brown root disease of trees.

臺東地區松露資源調查與接種培育計畫

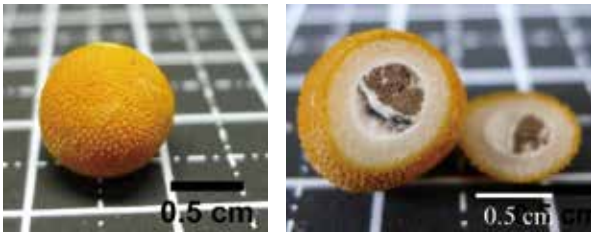
林介龍、張東柱、傅春旭、朱麗萍、黃曜謀、陳溢宏

完成臺東林區管理處所轄範圍之松露資源調查工作，共發現四種新種松露分別為假松露之奧腹菌屬(*Octaviania* sp. nov.) 1種及層腹菌屬(*Hymenogaster* sp. nov.) 1種；真松露之白塊菌(*Tuber* sp. nov.) 1種及大團囊屬菌(*Elaphomyces* sp. nov.) 1種。另外，亦成功將利嘉林道所發現具經濟價值潛力之白塊菌完成菌種分離及保存工作，後續利用除了提供食品業者嘗試發酵應用外，亦可用在篩選最適合宿主樹木之接種試驗上，以達到更高的品質及產量。完成5種殼斗科種子之種子消毒工作及持續進行半無菌苗木之培育，以作為後續接種試驗之用。以青剛櫟印度松露菌根苗及青剛櫟偽孔松露菌根苗完成延平(42林班)松露試驗區的造林地建置，確定已接種的青剛櫟松露菌根苗菌木根系與塊菌共生，形成菌根菌。完成長尾尖槠採種園的監測樣區設置，在100 m^2的實驗組樣區內以0.6 kg/m^2的石灰施用量，施用4次共60 kg石灰。施灑石灰後土壤酸鹼值有所增加，與未施用石灰的對照組比較，長尾尖槠樹木長勢健康並未出現任何病徵及生長障礙，另外於施灑石灰後的實驗組樣區編號1附近之長尾尖槠根圈發現塊菌子實體3顆。

奧腹菌屬新種子實體。A:外觀，B:剖面。
Fruit body of *Octaviania* sp. nov.. A: Appearance, B: Profile.

塊菌屬新種子實體。A:外觀。B:剖面。
Fruit body of *Tuber* sp. nov. A: Appearance. B: Profile.

層腹菌屬新種子實體。A:外觀。B:剖面。
Fruit body of *Hymenogaster* sp. nov. A: Appearance. B: Profile.



大團囊菌屬新種子實體。A:外觀。B:剖面。
Fruit body of *Elaphomyces* sp. nov. A: Appearance. B: Profile.

Investigation of truffle resources in Taitung area and inoculation and cultivation plan

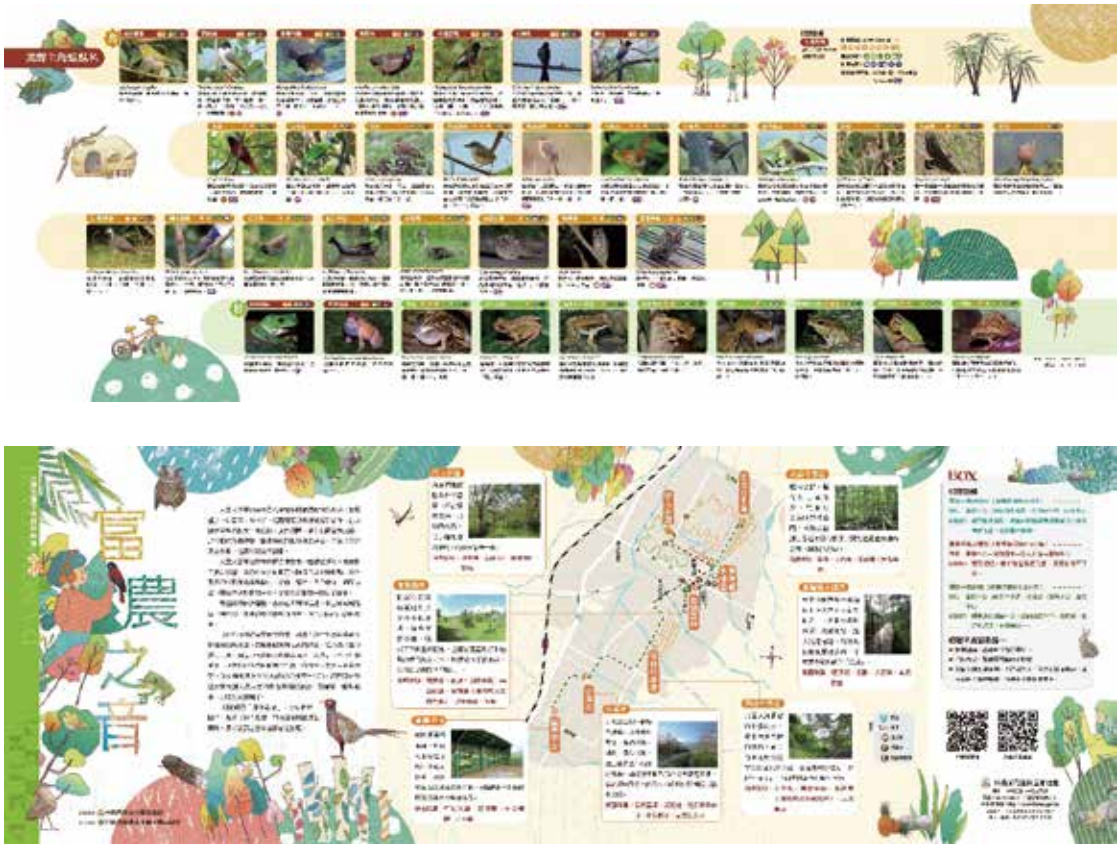
Chieh- Lung Lin, Tun-Tschu Chang, Chuen-Hsu Fu, Li-Ping Ju, Yao-Moan Huang, Yi-Hung Chen

The investigation of truffle resources under the jurisdiction of the Taitung Forest District Management Office was completed, and four new species of truffles were found, namely *Octaviania* sp. nov. 1 species and *Hymenogaster* sp. nov. 1 species; one species of True Truffle (*Tuber* sp. nov.) and one species of *Elaphomyces* sp. nov. In addition, the white truffles with economic potential discovered on Liga trail have been successfully isolated and preserved. The follow-up use can not only provide food companies to try fermentation applications, but also can be used in the inoculation test for screening the most suitable host trees. In order to achieve higher quality and yield. Complete the seed disinfection of 5 species of Fagaceae seeds and continue to cultivate semi-sterile seedlings for subsequent inoculation tests. Completed the establishment of afforestation in the Yanping (42 forest class) truffle test area with the Tuber indicum mycorrhizal seedlings of *Quercus glauca* and *Tuber pseudoexcavitum* mycorrhizal seedlings of *Q. glauca*, and confirmed the symbiosis of the mycorrhizal root system of the inoculated *Q. glauca* truffle mycorrhizal seedlings and the tuber. , The formation of mycorrhizal fungus. The monitoring sample area of the *Castanopsis carlesii* seed garden was set up. In the 100 m^2 experimental group sample area, the lime application rate was 0.6 kg/m^2, and a total of 60 kg lime was applied 4 times. The pH of the soil increased after liming. Compared with the control group without lime, the trees of *C. carlesii* grew healthy and did not show any symptoms or growth obstacles. In addition, the experimental group after liming was near No. 1 in the experimental group. 3 truffle fruit bodies were found in the root circle of *C. carlesii*.

大農大富平地森林園區聲音資源應用計畫

徐中芃、傅淑瑋、王培蓉

本計畫目的在於盤點大農大富平地森林園區中各式各樣的環境聲音資源，並探討環境裡的聲音在森林生態體驗或環境教育中的應用性。本計畫以106年6月至107年5月所調查的錄音資料為基底，進行自然音與非自然音的解析。結果顯示，車聲、火車聲、割草聲等非自然音佔整體錄音時間比例為29.8%。其中，非自然音比例最高為車聲。自然音的解析包括鳥音及蛙鳴，本計畫結果所得的鳥音共計77種，蛙鳴共計13種。在環境聲音的應用上，本計畫以特定物種及森林療癒為例。森林生態體驗中，一般民眾對於大型且漂亮的物種較感興趣，換言之，透過這些較具吸引力的特定物種，可促進一般民眾對森林保育或是環境教育的關注。因此，本計畫針對區內選定幾種特定物種，包括環頸雉、朱鸝、領角鴞及黃嘴角鴞等進行分析，並描述其易於聆聽的地點、月份與時段予以參考。另外，在森林療癒的應用上，本計畫針對區內選定幾種悅耳鳥音，例如畫眉類，並且搭配非自然音之調查成果，找出悅耳鳥音的種類以及其適合聆聽的場域與月份。本計畫研究成果一方面利用地圖或摺頁具體展現，以提供給管理者及遊客更完善及更便於利用的資訊；另一方面，透過課程學習加強平地森林志工對於環境聲音的理解，日後志工們進行森林遊樂解說服務及推廣自然保育理念的同時，也能適當地引領遊客多關注平地森林中的各種聲音。



聲音資源成果製成摺頁。
Results were displayed on a brochure.

Applications of sound in the Danongdafu Flatland Forest Park

Chung-Peng Hsu, Shu-Wei Fu, Pei-Jung Wang

The purpose of this project was to survey various environmental sounds in the Danongdafu Flatland Forest Park, and discuss applications of sound in forest ecological experience or environmental education. This project was based on the recording data surveyed from June 2017 to May 2018 to analyze natural and unnatural sounds. The results showed that unnatural sounds created by cars, trains, and mowing machines accounted for 29.8% of the total recording time. Among them, the highest proportion of unnatural sounds came from cars. The results of natural sounds include 77 bird species and 13 frog species. This project took specific species and forest therapy as examples for applications of sound. Publics are more interested in large and beautiful species in forest ecological experience. In other words, publics' attention to forest conservation or environmental education can be promoted through these attractive and specific species. Therefore, this project analyzed several specific species, including common pheasant(*Phasianus colchicus*), maroon oriole(*Oriolus traillii*), collared scops owl(*Otus bakkamoena*) and mountain scops owl(*Otus spilocephalus*), and describes their easy-to-listen locations, months and time periods for reference purposes. Besides, in the application of forest therapy, this project selected several pleasant bird sounds, such as hwamei, and matched the results of unnatural sounds to find out the types of pleasant bird sounds and their suitable places and months for listening. Finally, results were displayed on a brochure to provide managers and tourists with more complete and more convenient information; on the other hand, through course learning, we leveled up forest volunteers' understanding of environmental sounds, let them can appropriately lead tourists to pay more attention to the various sounds.

原鄉特用植物培育及複層經濟林營造

林鴻志、游漢明、何姍穎、黃建益

原住民保留地諸多桂竹林面臨老化及閒置的情形，為促進桂竹林分更新、發揮林地多元效益、增進原鄉經濟收益、活化林地經營，本所在原住民族委員會委託及經費支持下，開始進行具原鄉文化特色或經濟潛力的特用植物育苗試驗與相關培育工作。

109年度進行了山肉桂(*Cinnamomum osmophloeum*)的扦插與種子發芽試驗，大丁黃(*Euonymus laxiflorus*)的扦插與種子發芽試驗，另外也進行山胡椒(*Litsea cubeba*)、阿里山十大功勞(*Mahonia oiwakensis*)、台灣天仙果(*Ficus formosana*)等的種子發芽試驗。並於新竹縣尖石鄉建立起老舊桂竹林建構複層經濟林的示範地。試驗初期依竹林密度與株距，對林分進行了70%高強度、30%弱強度的疏伐作業及樣區設置，調節林分的光度環境，並於林內栽植大丁黃、山肉桂、阿里山十大功勞、台灣天仙果等低光度需求的耐陰性特用植物，於森林邊緣則選種山胡椒、金銀花(*Lonicera japonica*)等需光的陽性植物，另同時撫育林內自然生長具經濟價值之原生特用植物苗木；每季持續觀察各特用植物於不同光度環境下之生長速度及成活率，並與未疏伐整理之對照區林分進行適應性監測與比較，作為未來特用植物林地內栽植撫育技術之參考。

考量植物採收模式有全株採收或挖掘根株之需要，本研究嘗試發展台灣天仙果、阿里山十大功勞、金銀花等植物之地上容器苗栽培系統，減少對水土保持之衝擊，也方便林農採收作業，未來將與土地栽種苗進行生長比較，並持續開發環保永續、低成本的容器材質。

適度疏伐竹林促進更新，調節林下光度環境。
Thinning the bamboo forest for regeneration and adjustment of light intensity under forest.

Natively Specific Plants Breeding and Economic Multi-layered Forests Construction in Indigenous Areas

Hung-Chih Lin, Han-Ming Yu, Shan-Ying Ho, Chien-I Huang

Many Makino bamboo forests in aboriginal reserves are facing the aging and idle situation. Commissioned and funded by the Council of Indigenous Peoples, Taiwan Forestry Research Institute carried out nursery experiments and related cultivation works to specific plants with native cultural characteristics or economic potential locally, for the purposes of regenerating the bamboo stands, creating diversified benefits of land use, promoting incomes of indigenous villages, and activating the management of forest land.

In 2020, we proceeded with the cutting propagation and germination experiments to specific plants, such as *Cinnamomum osmophloeum* and *Euonymus laxiflorus*. Germination experiments to *Litsea cubeba*, *Mahonia oiwakensis* and *Ficus formosana* were also implement. The demonstration site of economic multi-layered forest was constructed from the elder and disused Makino bamboo forest in Jianshi Township in Hsinchu County. We set the sites to 70%, 30% and 0% cut out plots with different densities and their distances, and monitored the light environment under forest stands were monitored. Then, the growth and survival rate of different kinds of specific plants, including shade-tolerated and light-preferred species cultivated in above mentioned thinning stands will be investigated for continuously few years. Results will be helpful for decisions to choose suitable target species as well as cultivation techniques.

As considering the plant harvesting operations, there are needs for whole plant harvesting or root excavation. The research also attempts to develop an above-ground container system for cultivating natively specific plants such as *Ficus formosana, Mahonia oiwakensis*, *Lonicera japonica*, etc. This system may reduce the soil impact for water conservation and also facilitate the harvesting operations of forest farmers. The growth of seedlings grown between on the ground and above-ground container will be compared, and environmentally sustainable, low-cost container materials will be continuously developed in the coming year.

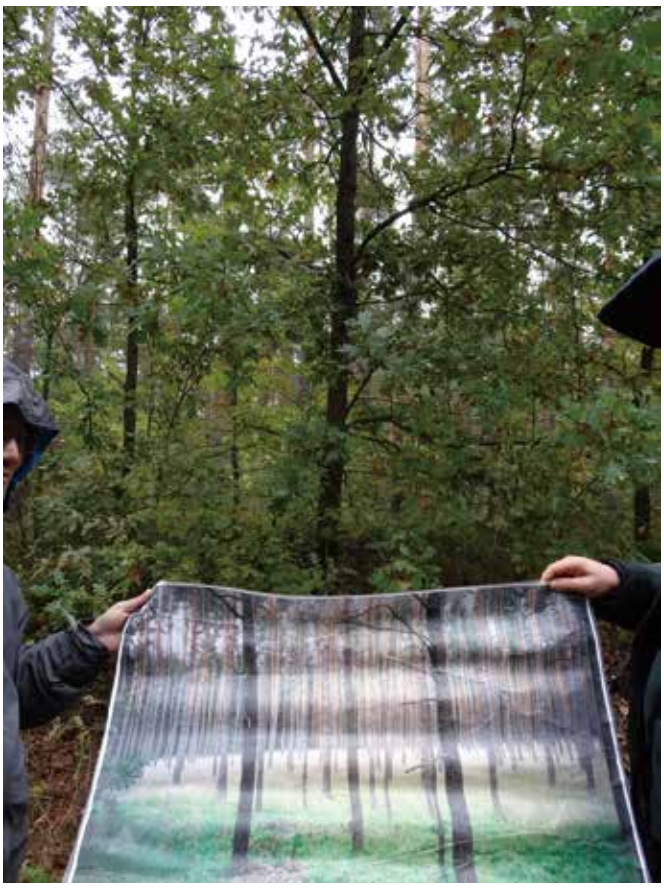
地上容器苗栽植試驗。
Cultivation experiment of above-ground container system.

都市林在韌性城市的規劃面向與實務交流計畫

王培蓉

全球高度趨向都市化的結果，造成都市擴張、土地利用變化及全球環境衰退的後果。聯合國開發計畫署與生物多樣性公約莫不把都市森林、樹木與綠色建議做為對抗氣候風災、提高城市韌性的對策。臺灣都市化人口比率近80%，卻僅有3.6%的綠覆率，臺灣大多數居民等同於居住在城市沙漠之中，與周遭的山林、里山生態、溼地、海岸林失去連結。本計畫旨在掌握都市林的國際倡議趨勢，提高城市生物多樣性以提供人類和不同物種及環境生態間共享的具體作法與樣態；同時，鼓勵多元參與及地方創生，強化管理機構與使用者間的溝通，建構開放式都市林管理系統。

本計畫參訪德國都市林與行道樹綠帶，包括德國烏茲堡城市與園林綠化研究所、慕尼黑工業大學，以及柏林市森林局等，討論「Urban Green 2021」計畫、都市設計與環境衝突、以及都市林的生態服務等實際的作法。有利於應用於氣候變遷下都市林的整體架構與擬訂執行對策。在日本的未來都市願景，從地方創生來解決環境、社會與產業問題，並從2/3國土均為森林所覆蓋的林業聚落中，創造地方地方政府與各地區利益關係者積極投入、活化林產業、社區關懷、創造吸引人才進駐的居住環境，是解決山村高齡化與城鄉差距加大的重要區域及人口政策，值得持續了解與關注。



德國柏林市以近自然林經營方式改善都市林的結構。
Close-to-Nature Forest Management is a strategy to improve urban forest structure in Berlin, Germany.

Planning and Practical Exchange Program of Urban Forests in Resilient Cities

Pei-Jung Wang

Urban expansion, land-use change and global environmental degradation are caused by the global trend towards urbanization. Both the United Nations Development Program and the Convention on Biological Diversity use urban forests, trees and green proposals as countermeasures against climate disasters and enhance urban resilience. In Taiwan, urban population ratio is nearly 80%, but only 3.6% spatial green coverage in urban area. Most residents lose their connection with the forests, satoyama, wetlands, and coastal forests. This project aims to grasp the international initiatives direction of urban forests, and improve urban biodiversity to provide specific practices and patterns shared between humans and different species and environmental ecology; Meantime, encouraging diverse participation and regional revitalization and increasing communication between local government and users have constructed an open urban forest management system.

The plan has implemented a visit to the urban forests and street green belt in Germany, including Würzburg Urban Greening and Landscaping Institute, Germany, Munich Industrial University, and Forest Bureau in Berlin City, we have also discussed about the "Urban Green 2021" project, and practical practices such as urban planning and environmental conflicts, and ecological services in urban forests. It's conducive to the overall structure of urban forests under climate change and the formulation of implementation strategies. In Japan's vision of the future city, regional revitalization policy is used to solve environmental, social and industrial issues. 2/3 of the country being covered by forests, Important regional and population policies that address the aging of mountain villages and the increasing gap between urban and rural areas will be resolved from the involvement of local governments and stakeholders, the recovery of forest industrial, the concerns of communities' desires, and the returns of youth and talent manpower.

林木種原保存與利用研究

陳怡蒨、吳家禎

台灣森林遺傳資源豐富，林試所多年來蒐集了許多珍貴林木種原並且發展組織培養保存生產苗木以及分子標誌應用，同時陸續開發選育出不同樹種的細胞株和毛狀根，可以用於生產諸如喜樹鹼以及紫杉醇等高經濟價值的二次代謝產物。本計畫針對多年來收集保存的26種珍貴森林物種進行繼代培養，並對於優良牛樟品系進行一系列的組織培養苗培育，於計畫執行期間促成了3件牛樟優良組培品系的技轉，提供20000株產業造林之需。為了降低繼代培養的成本，本計畫針對土肉桂芽體進行2年期的低溫保存培養試驗，完成不同培養基成分以及貯存溫度，對芽體存活率的影響評估，建立了土肉桂芽體低溫長期保存的技術。另外，針對已建立之青脆枝及台灣紅豆杉之毛狀根與癒合組織，定期調查毛狀根及癒合組織生長情形並利用HPLC檢測二次代謝物含量，藉此篩選生長佳與二次代謝物含量高之毛狀根與細胞系，可供未來產業發展應用。

在DNA遺傳分析上，藉由單一核苷酸多型性，微衛星體序列以及插入缺失序列，除了建構牛樟、土肉桂、紅豆杉、樟樹、右樟、山櫻花的葉綠體基因組外，更成功鑑別牛樟，並且證實天然雜交牛樟的父本為樟樹。研究數據也證實林試所移地保存牛樟的策略有助於遺傳多樣性的維持，但牛樟的遺傳歧異度，性較台灣其他樹種為低，表示牛樟的復育還需要努力，而在牛樟種子苗的培育，則必須排除與他種雜交，同時也要持續發展深化無性繁殖技術。

新植1年的牛樟種原暨採穗園現況，存活率高達80%以上(2021年5月拍攝於信賢苗圃)。
One year old *C. kaneahirae cutting* plantation in Sinxian nursery, Wulai. (photographed in May, 2021).

Study on preservation and utilization of forest tree germplasms

Yi-Chiann Chen, Chia-Chen Wu

Taiwan is rich in forest genetic resources. The Taiwan Forestry Research Institute (TFRI) has collected many precious forest tree germplasms for many years and established tissue culture preservation systems and develop molecular marker technology in different tree species for commercial utilization. At the same time, we have successively developed cell lines and hairy roots of different tree species, which can be used to produce secondary metabolites of high economic value such as camptothecin and paclitaxol. This project carried out the subculture of 26 precious forestry species for germplasm conservation. In 2020, 3 technology transfers of *Cinnamomum kanehirae* tissue culture lines were promoted, and a total of 20,000 tissue culture *C. kanehirae* seedlings were cultivated for industrial afforestation. In order to reduce the cost of subculture, this project conducts a 2-year low-temperature storage and culture test for *Cinnamomum osmophloeum* to evaluate the effects of different medium components and storage temperature on the survival rate of buds, and then established a long-term preservation technology at low temperature for *C. osmophloeum* buds. In addition, for the established hairy roots and callus of *Nothopodytes nimmoniana* and Taxus sumatrana, we regularly investigate the growth of hairy roots and callus and use HPLC to detect the content of secondary metabolites to screen elite hairy root and cell lines with better growth and high content of secondary metabolites for future industrial development and application.

Single nucleotide polymorphism, microsatellite sequence and indel were used for genetic analysis. We constructed and released the chloroplast genomes of *C. kanehire*, *C. camphora*, *C. micranthum*, *C. osmophloeum*, *T. sumatrana* and *Prunus campanulate*. The data also showed that TFRI researchers used the strategy of ex-situ conservation in *C. kanehirae* is helpful for maintain the genetic diversity. However, the genetic divergence of *C. kanehirae* is lower than that of other tree species in Taiwan, indicating that the continuously restoration of *C. kanehirae* is necessary. For the cultivation of *C. kanehirae* seedlings, it is necessary to exclude the hybridization with other species and continuously developing the asexual reproduction such as tissue culture, cutting.

台灣人工林經濟造林樹種育林技術之研究

游漢明、鍾振德、蔡佳彬、吳家禎、杜清澤、陳怡蒨

本計畫為提高香杉、台灣肖楠、相思樹與櫸木生長量的育種研究計畫，計畫透過精英樹的篩選，建立4個樹種之營養系種子園與建立其營養系林。首先，篩選得精英母樹，取其枝條為接穗嫁接在2年生種子苗砧木，培育嫁接苗木。香杉與台灣肖楠從單親後裔試驗林選育之精英樹100%成功嫁接繁殖，並於南投建立0.7公頃香杉嫁接營養系種子園。相思樹篩選材積生長量超過2立方公尺有3株母樹，以高壓繁殖可以成功的培育苗木。櫸木36株精英樹以嫁接與高壓苗培育完成。SSR分子標誌分析香杉種子園的後裔，透過SSR 共顯性引子分析，完成7個後裔的父本推估。為了解種子園的土壤養分狀況，完成所有種子園的土壤調查。由於香杉、台灣肖楠、相思樹與櫸木精英樹篩選，母樹很難發根，利用樹幹基部萌芽取得幼年化的插穗，以此作為扦插繁殖的材料，才能建立其營養系林。香杉與相思樹精英樹的發根率差異大，從0~100%皆有。因此我們建立香杉之精英樹之無菌芽體與芽體培養系統，櫸木可以利用半木質化枝條可以成功獲取扦插苗。未來四年我們將經由育種提升遺傳增益以及由種子園充足提供種子做後續育苗。

香杉單親後裔試驗林選育之精英樹嫁接苗木培育。
Grafts of *Cunninghamia konishii* elite trees from half-sib progeny tests.

Study on the silviculture techniques of high economic value tree species in Taiwan plantation (1/1)

Han-Ming Yu, Jeng-Der Chung, Jia-Bin Tsai, Chia-Chen Wu, Chin-Tzer Duh, Yi-Chiann Chen

The project was dedicated to doing a research of increasing biomass production through breeding in *Cunninghamia konishii*, *Calocedrus formosana*, *Acacia confusa* and *Zelkova serrata*. The breeding program includes selection of elite trees and establishment of clonal seed orchards as well as clonal forestry. At first, we selected elite trees used as scion that is grafted onto the 2-year-old seedlings rootstocks. Propagation of *C. konishii* and *C. formosana* by grafting and 100% of elite trees from half-sib progeny tests were successfully propagated. We also had established 0.7-hectare clonal seed orchard of *C. konishii* in Nantou. Moreover, the wood volume of 3 *A. confusa* elite trees are over 2 cubic meters; the elite trees were successfully cultivated by air-layering. Furthermore, 36 elite trees of *Z. serrata* were successfully cultivated by grafting and air-layering. Besides, the marker, simple sequence repeats (SSRs), was used for paternity testing of *C. konishii*. In paternity analysis of the seed orchard, 21 codominant SSRs were used, we estimated the parents of 7 offspring successfully. In order to investigate the soil nutrient status, soil surveys were also conducted in all seed orchards. Second, owing to the difficult-to-root elite trees of *C. konishii*, *C. formosana*, *A. confusa* and *Z. serrata,* we decided to rejuvenate above species by stump sprouts as sources of cutting production for the vegetative propagation. Rooting percentages of cuttings varied among elite trees of *C. konishii* and *A. confusa*, ranging from 0 to 100%. Besides, the buds sterilization and cultivation test of individual elite trees have been carried out in *C. konishi*. In addition, the cutting propagation of *Z. serrata* have been accomplished by semi-hardwood stem. At last, the following four-year project is to establish programs to increase genetic gain through breeding and sufficient planting seeds were supplied from seed orchards.

香杉種子園雄毬花。
Male cone of *Cunninghamia konishii* in seed orchard.

多元生態林業生產體系之研究

陳芬蕙

本研究以過去林業試驗所曾收集種源多樣性高之土肉桂、牛樟、小果油茶三種樹種為主要經營研究目標，以開發未來具可以推廣潛力之品種。

土肉桂進行葉部不同季節有效成分(肉桂醛及伽羅木醇)與有毒成分(香豆素)之分析，以篩選出有效成分濃度較為穩定之單株，並避免有毒成分。結果發現這些不同單株之化學成分與組成會隨採集地區、季節、栽植地區與單株個體差異而有所不同。若比較栽植於同處且採集自同一地區之不同單株，其主要成分於各採集季節組成趨勢大致相同。比較採集自同一地區但栽植於不同處之土肉桂個體可發現其差異，此差異可能是受到栽培地自然環境及管理之影響。

牛樟造林木以收穫木材為主，如果能從葉部開發具有生產潛力之成分，將可提升林產品之多元性。葉部含量有效成分以伽羅木醇及芝麻素為主，但大部分之個體季節濃度變化很大，有時甚至未檢出。有毒之黃樟素於今年度分析之葉部樣本未檢出。

103年設立栽植於蓮華池研究中心之俗稱小果油茶之短柱山茶(Camellia brevistyla)家系試驗圃，生長良好之單株開始大量生產茶籽，栽植6年後綜合考量植株大小與產量，以家系16為最適合栽植於蓮華池之家系。透過收集其他原生山茶屬種子，包括鳳凰山茶(*Camellia japonica* var. *hozanensis*)、垢果山茶(*Camellia furfuracea*)、恆春山茶(*Camellia hengchunensis*)等可榨油樹種種源，可做為未來研發之基礎。

103年設立栽植於蓮華池研究中心之小果油茶家系試驗圃。
A family comparative test garden of *Camellia brevistyla* at Lienhuachih Research Center was established in 2014.

Establishment of Production System of Ecological Forestry with Multi-Function

Fen-Hui Chen

The three main target species of this study are *Cinnamomoum osmophloeum*, *Cinnamomumhanehirae*, and *Camellia brevistyla*. Different provenances with high diversity were collected in the past at Taiwan Forestry Research Institute. The purpose of this research is to find the potential valuable varieties of these three species for future promotion of plantations.

Leaves of *Cinnamomoum osmophloeum* were analyzed of the useful chemicals (cinnamaldehyde and linalool) and the toxic chemical (coumarin) in different seasons. Therefore, individuals with relatively stable concentration of useful chemicals can be selected, while those with toxic chemical can be avoided. The results showed that the type and content of chemicals are varied by the collected region, sampled season, planted area, and individual character. Different individuals collected from the same region and planted at the same site have similar seasonal change patterns of their compounds. However, the chemicals of individuals collected from the same region but planted at different sites may be different. This might be influenced by the natural environmental factors and managements.

Cinnamomum hanehirae trees plantations are mainly for harvesting timber. If some potential useful chemicals can be utilized from the leaves, the diversity of its forest products will be improved. The main useful contents of the leaves are linalool and sesamin. The concentrations of the 2 compounds changed considerable among seasons, and even was not detected sometimes. The toxic safrole was also not detected in all our leaf samples analyzed this year.

In 2014, the family comparative test garden of *Camellia brevistyla* at Lienhuachih Research Center was established. After 6 years, some well-growing individuals began to produce many tea oil seeds. Considering both the growth and fruit production, family 16 is the most suitable family at this area. Collecting of other native genus *Camellia* plants, such as *Camellia japonica* var. *hozanensis*, *Camellia furfuracea*, *Camellia hengchunensis*, whose seeds have high tea oil can provide the material for future research and development.

7年生烏　大果品系斷頂營造結果枝。
The branching of topping tree on 7-year-old plantation of *Triadica sebifera*.

特用林木油脂生產與加值利用

馬復京

瓊崖海棠種實生產林經營技術方面我們的研究結果顯示，瓊崖海棠造林木在持續刈草施肥的經營下，可於3年後進入開花結實齡，而盛產齡應在5~7年生以後。此外透過高磷肥緩效型複合肥料的深層(30 cm)施肥作業，可以促進結實齡林木的開花結實量，但在單株之間仍有差異存在，顯示單株立地或遺傳的差異。台中清水試區7年生瓊崖海棠林2020年的結實量為202.75 kg，結實株數73株，相較於2019年(6年生)未施肥前的87.95 kg，結實株數45株的結果，顯示複合高磷肥的施用有益於瓊崖海棠造林木後續的開花結實，也促進了單株的結實量。

烏　種源後裔及種實生產林的營造，花蓮大富試區造林2年的結果，5個單株種源後裔以小徑2號有最佳的樹高及胸徑生長，依序為401.9±78.4 cm及4.1±1.3 cm，目前已有少數單株萌生雄花。此外2020年4月針對7年生大果烏　品系造林木進行疏伐及截幹作業，截幹高度為2 m，以營造結果枝，同時也進行緩效肥料的深層施肥作業。目前萌　枝在8~18支，平均10±6支。萌蘗枝長2~3.5 m，平均2.5±1.2 m，萌蘗枝徑2.2~3.2 cm，平均2.6±0.9 cm。

7年生瓊崖海棠造林木著花旺盛，顯示深層施肥的效果。
The blossoming tree of 7-year-old *Calophyllum inophyllum* plantation which revealed the effects of deep soil depth fertilization.

The study on the cultivation and seed oil utility of the oil trees

Fu-Ching Ma

The study result on the tending of *Calophyllum inophyllum* plantation for seed mass production reveal that constantly weeding and deep soil depth (30 cm) fertilization with high phosphor nutrient of compound fertilizer will enrich the tree flowering and mass seeding while there is a variation among the trees or site differences. The first flowering was emerged at 3-year-old plants then it will reach to the mass flowering and seeding at 5~7-year-old. The fruiting mass on 7-year-old plantation of *C. inophyllum* at Chinxuei plot was 202.75 kg with 73 trees in 2020 which compare to 87.95 kg with 45 trees before fertilization in 2019. It was showed that high phosphate fertilizer will benefit for the flowering and seed mass production. The progeny test of 2-year-old plantation of 5 selected Triadica sebifera trees showed that Xiaujin 2 performed the highest of growth on tree height and diameter of breast height (DBH) on 401±78.4 cm and 4.1±1.3 cm respect. Although there were some trees recorded to the first flowering. A select cut and topping on 2 meter in height on the 7-year-old trees of bigger fruit variety was conducted for the fruiting manipulation meanwhile the deep soil depth fertilization were also accomplished at 2020. The sprouting number per tree was 8 to 18 while the mean sprouting was 10.0±6.0. The spouting length was 2 to 3.5 m in range and the mean length was 2.5±1.2 m. The sprouting base diameter ranged from 2.2 to 3.2 cm and the mean diameter was 2.6±0.9 cm.

7年生烏桕大果品系斷頂營造結果枝。
The branching of topping tree on 7-year-old plantation of *Triadica sebifera*.

臺灣山茶應用於林下經濟之研究

The study on the under-forest economy of *Camellia formosensis*

陳永修、周富三、林文智
Yung-Shui Chen, Fu-shan Chou, Wen-Chin Lin

臺灣山茶是應用於林下經濟的一種極具潛能的植物，為了讓臺灣山茶發揮其經濟性、公益性及永續性，本試驗主要目的在調查臺灣山茶的物候及種子的生理。結果顯示臺灣山茶的主要開花期在1月上旬至3月上旬，從開花到種子發育與充實的成熟期至少需8個月，以11個月達到最佳的狀態，12個月後果實乾裂，種子水分散失而掉落。因此，建議12月份為種子最佳採收期。在臺灣山茶種子發育與充實成熟期間採收的種子，其發芽率及苗木的生長量，明顯要高於種子發育與充實未成熟期間採收的種子。

Camellia formosensis is a potential plant on under-forest economy. In order to give consideration to economy, public welfare and sustainability, it is necessary to do the research about physiology and ecology. The purpose of this experiment study is to investigate phenology of *Camellia formosensis* predicting the optimization time for seed harvesting. The results showed that the major flowering period of *Camellia formosensis* was from early January to early March, and the seed development and filling period of *Camellia formosensis* was 11 months to reach the harvest maturity. After 12 months, the fruit was dry and cracked, and the seed water was dispersed and dropped. Therefore, it is recommended that December be the best harvest time for seeds. The germination rate and growth of seedlings of *Camellia formosensis* seeds harvested during the development and maturity are significantly higher than those harvested during the immature period.

林下經濟特用作物研發

The development of economic forest byproducts under forest canopy

黃曜謀、楊正釧、傅春旭
Yao-Moan Huang, Jeng-Chuann Yang, Chuen-Hsu Fu

臺灣水龍骨為防曬及抗老化護膚產品的原料，建立其綠球體繁殖系統，有利於商業性生產。本研究以幼孢子體頂芽誘導形成綠球體，再搭配不同濃度NAA及kinetin處理促進綠球體增殖。當綠球體移至含有活性碳的培養基，6個月後會生長出幼孢子體。

觀察記錄具藥用潛力樹木食茱萸其各開花及結實情形，並採集足量種子以進行發芽與儲藏性質之研究，明瞭其種子的發芽條件機制及儲藏條件，以作為將來大量經濟生產之基本。

將華山松、五葉松、二葉松、青剛櫟及小西氏石櫟苗，利用固態及液態兩種深脈松露的接種源進行根系接種。培養4個月後進行苗木檢定，發現苗木根系皆有菌根形成，抽取菌根之DNA進行比對，確認形成菌根的真菌為深脈松露。

Goniophlebium formosanum is a material for sunscreen and anti-aging skin care product. Its green global body reproduction system is established for commercial production. In this study, green global body can be successfully induced from terminal buds of young sporophytes. Then green global body subsequently treated with various concentrations of NAA and kinetin to promote proliferation. As the green global bodies subculture to a medium containing active carbon, they would successfully grow out young sporophytes after 6 months culture.

The study is to investigate such phenology data as blossom and fruit of the tree species *Zanthoxylum ailanthoides* with medical potential. Moreover, enough excellent seeds will also be collected to put seed germination condition and seed storage behavior into practice. The results can provide useful database for further economical production of *Zanthoxylum ailanthoides*.

The seedlings of *Pinus armandii*, *P. morrisonicola*, *P. taiwanensis*, *Cyclobalanopsis glauca* and *Lithocarpus konishii* were inoculated with solid and liquid cultured inoculum of *Tuber elevatireticulatum*. Four months after inoculation, mycorrhiza formation on the roots of those seedlings were found. The DNA of the mycorrhiza was compared to confirm that the fungus forming the mycorrhiza was *Tuber elevatireticulatum.*

臺灣水龍骨綠球體繁殖。
Propagation of *Goniophlebium formosanum* by green global body.

食茱萸果實。
Fruits of *Zanthoxylum ailanthoides*.

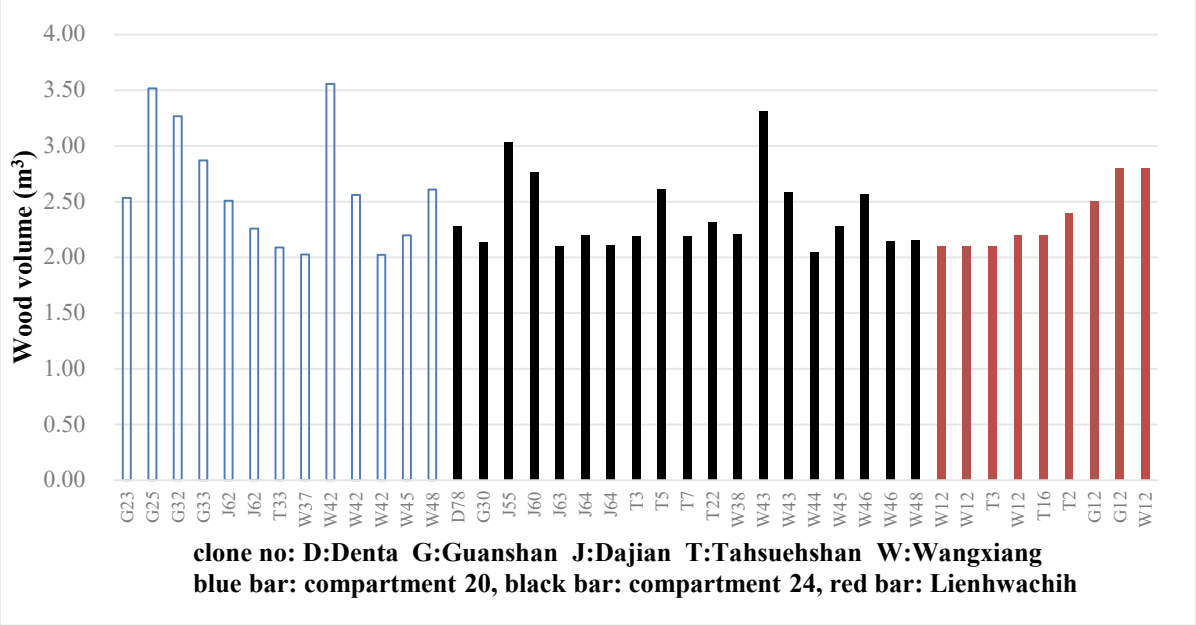
五葉松根系上形成之菌根。
Mycorrhizal root of *Pinus morrisonicola* inoculated with *Tuber elevatireticulatum*.

五葉松深脈松露菌根苗。
Mycorrhizal seedling of *Pinus morrisonicola* inoculated with *Tuber elevatireticulatum*.

台灣杉優良種源選育與苗木之生產

鍾振德、蔡佳彬

本研究計畫目標希望藉由育種選育提高台灣杉之生長量，由蓮華池與六龜20與24林班之台灣杉單親後裔試驗林的生長調查資料，篩選得精英母樹，利用嫁接與扦插進行繁殖。在3個試驗地共計篩選41株優良母樹，取其枝條為接穗嫁接於2年生種子苗之砧木上，共成功繁殖33株優良母樹嫁接苗木。選育的41株母樹的單株材積量超過2立方公尺，篩選的單株母樹材積生長量最高為20林班望鄉42號，單株材積可達3.6立方公尺。本計畫目標設定35年為一個伐採循環，預期每公頃至少有1200立方公尺的生長量，此育種研究對於台灣杉後續的推廣將提供很優的基礎。



從蓮華池與六龜20及24林班台灣杉單親後裔試驗優良種源選育41株單木材積超過2 m^3。

The selection of elite *Taiwania cryptomerioides* parental trees from half-sib progeny tests in the Lienhwachih and compartment 20 and 24 of Liukuei Experimental Forest. 41 elite trees volume are over 2 m^3.

The selection of elite *Taiwania cryptomerioides* parental trees and vegetative propagation

Jeng-Der Chung, Jia-Bin Tsai

The project was dedicated to doing a research of increasing biomass production through breeding in *Taiwania cryptomerioides* Hay. Firstly, we selected elite trees from the results of half-sib progeny tests in the Lienhwachih and compartment 20 and 24 of Liukuei Experimental Forest as well as propagated them using grafting and cuttings. Secondly, we selected 41 elite trees used as scion that is grafted onto the 2-year-old seedlings rootstocks; 33 elite trees were successfully cultivated. Meanwhile, the 41 elite trees volume are over 2 m3; the biggest wood volume of mother tree no. W42 (Wangxiang) is 3.6 m3 in compartment 20 of Liukuei Experimental Forest. Therefore, the project goal refers to achieving the total commercial volume which is 1200 m3 per hectare with a 35-years cutting cycle.

六龜20林班精英樹單木材積3.6 m^3及其嫁接苗木。

Elite tree (wood volume 3.6 m3) of *Taiwania cryptomerioides* from half-sib progeny tests in the compartment 20 Liukuei Experimental Forest(left), and it' s grafts).

太麻里台灣杉人工林育林體系之研究

楊蒼叡、胡元瑋、鍾振德

太麻里試驗林面積974 ha，包含235 ha的人工林，其中台灣杉人工林面積108 ha占人工林總面積46%，因此太麻里經濟性人工林育種選育應聚焦在台灣杉。但台灣杉達到開花結實年齡超過四十年以上，即使利用嫁接成熟組織以縮短開花結實時間，目前被證實至少需要十八年以上，此關鍵問題對於台灣杉種子之獲取以及育種之需求非常不利。為解決此問題，可在太麻里試驗林建立台灣杉的種子園與採穗園，生產經過育種選育的台灣杉苗木，以提高林業試驗所經濟人工林的生產量。為選育出適合太麻里生長的台灣杉種原，本計畫將以太麻里地區於1982年設置之台灣杉種原後裔試驗區內台灣杉試驗樣木為目標，以38年生之台灣杉試驗木生長情形，作為選擇優良母樹之依據，以建立後續種子園與採穗園。

本計畫於2020年3月進行種源後裔試驗林生長調查與優良母樹之篩選，於太麻里試驗林台灣杉後裔種源試驗區內調查台灣杉試驗木共491株，並從中挑選胸徑大於40cm、生長良好，樹形完整之30株台灣杉試驗木作為優良母樹，以此進行下一階段的苗木之培育。本試驗同時使用嫁接及扦插方式進行台灣杉苗木培育，採取前述優良母樹靠近樹冠頂端直立且生長健壯之枝條作為穗條，以無性繁殖技術培育優良母樹之苗木。未來將在太麻里地區選擇適當的地點建立台灣杉採種園及採穗園，以期能生產大量且優良之台灣杉種子苗及扦插苗木，供太麻里台灣杉造林計畫使用。

太麻里台灣杉優良母樹扦插育苗。
Cutting propogation with good mother tree of Taiwan fir in Taimali.

Siliviculture and production development of Taiwan fir(*Taiwania cryptomerioides*) plantation in Taimali research center.

Tsang-Ruei Yang, Yuan-Wei Hu, Jen-Der Chung

The breeding of economic plantation in Taimali should focus on Taiwan fir(*Taiwania cryptomerioides*) because it accounted for 46% of the total plantation(235 ha) in Taimali experimental forest. However, it takes more than 40 years for Taiwan fir to reach the flowering and fruiting age. Even if the grafting of mature scions onto rootstocks is used to shorten the period, it will take at least 18 years. This is a disadvantage for Taiwan fir's seed acquisition and breeding needs. To solve this problem, Taiwan fir seed and clonal gardens should be established in the Taimali experimental forest to produce Taiwan fir seedlings that have been breeding and selected, to increase the production of economic artificial forests in the Taiwan forest research institute. We aim to select suitable Taiwan fir strains for growth in Taimali from an experimental Taiwan fir plantation set up in 1982 in Taimali experimental forest. The performances of 38-year-old Taiwan fir are used as a basis for selecting good mother trees to establish subsequent seed and clonal orchards.

In March 2020, the growth survey and the selection of good mother trees had been conducted. A total of 491 Taiwan fir trees were investigated, and 30 Taiwan firs which are healthy and straight-trunked and have a diameter at breast height greater than 40 cm are selected and used as good mother trees for the next stage of seedling cultivation. Both grafting and cutting methods were used to cultivate seedlings of good mother trees of Taiwan fir. In the future, suitable locations would be found in Taimali experimental forest to establish Taiwan fir seeding and clonal gardens, to produce a large number of high-quality seedlings, and cutting seedlings for use in Taimali Taiwan fir afforestation projects.

太麻里台灣杉優良母樹嫁接育苗。
Grafting propogation with good mother tree of Taiwan fir in Taimali.

台灣杉優良母樹採取無性繁殖穗條。
Collecting cutting and grafting materials from good mother tree of Taiwan fir.

六龜台灣杉人工林育苗體系之建立(1/1)

蔡佳彬、鍾振德

天然林之台灣杉達到生殖成熟且產生有效種子需要100年以上，人工林也至少要45年生才開始結實。六龜試驗林從1972年到1986年共建造約840公頃台灣杉人工林，至今都尚未發現雌雄毬花。1940年建立的80年生試驗木已經進入生殖期且有產生毬果。本計畫為建立六龜試驗林台灣杉營養系育苗體系，包括扦插與嫁接之營養系繁殖。在轄區內的20與24林班內的台灣杉種源後裔試驗林，選擇生長最優的61株母樹，取其枝條為接穗嫁接於2年生種子苗砧木，共培育成功39株母樹嫁接苗木。台灣杉母樹基部萌芽罕見，樹幹枝條扦插繁殖不易，發根率僅10%。本計畫將以此39株精英樹嫁接苗木，建立嫁接營養系種子園建立其種子園，處理誘導萌芽或開花，以此建立優良母樹的育苗體系供應人工林建造所需。

台灣杉精英樹之接穗嫁接於2年生種子苗。
Elite trees of *Taiwania cryptomerioides* used as scion that is grafted onto the 2-year-old seedlings rootstocks

The vegetative propagation system of *Taiwania cryptomerioides* in the Liouguei Experimental Forest plantations

Jia-Bin Tsai, Jeng-Der Chung

In natural forest, *Taiwania cryptomerioides* requires more than 100 years to reach sexual maturity and produces viable seed. In plantation, it also takes at least 45 years for seed cone production. From 1972 to 1986 in Liukuei Experimental Forest, nearly 840 ha of *T. cryptomerioides* plantations were planted, but they did not appear male and female strobili. However, we found that *T. cryptomerioides* had matured at 80 years old in 1940 in Liukuei's plantation. Moreover, we had set up a cuttings and grafting propagation system in order to produce *T. cryptomerioides* transplants at Liukuei Experimental Forest. At first, we selected elite trees from the results of half-sib progeny tests in compartment 20 and 24 in Liukuei Experimental Forest. Secondly, we selected 61 elite trees used as scion that is grafted onto the 2-year-old seedlings rootstocks; 39 plus trees were successfully cultivated. Nevertheless, stump sprouts as sources of cutting production for the vegetative propagation is rare in *T. cryptomerioides*, so the rooting percentage of cuttings is only 10%. Therefore, this project aims to set up clonal seed orchards by the grafts of the 39 elite trees for inducing sprouting and flowering of the species.

六龜1940年栽植之台灣杉人工林80年生已經成熟結實。

T. cryptomerioides had matured at 80 years old in 1940 in Liukuei's plantationplantation.

符合森林認證原則之人工林疏伐策略技術研發(3/3)

湯適謙、彭炳勳、蘇聲欣、徐中芃

人工林疏伐撫育作業是多元化育林體系主要一環，可促進留存木材積、形質之生長，並對整體之碳吸存具正面之效益。本研究於林業試驗所經FSC森林認證之蓮華池研究中心60年生台灣肖楠人工林進行疏伐作業，調查所得結果為疏伐區之平均胸徑26.0cm，平均樹高19.4m，蓄積量373m^3/ha；未疏伐區之平均胸徑22.7cm，平均樹高18.2m，蓄積量346m^3/ha，各項林分屬性值疏伐區均較未疏伐區高。且疏伐區之相對光度及孔隙增加，產生大量之天然更新小樹，而營造成複層林樣貌之森林景觀。由於進行森林認證時常聚焦於林木收穫作業，因此發展友善環境之作業技術為重要之工作，其技術包括應用架空索方式進行集材，及伐採作業時避免留存木損傷之施業技術，並於伐採前、伐採中及伐採後進行各項環境資源調查、教育訓練、社區影響調查及勞工職業安全訓練等。另外本研究亦前往民間經FSC森林認證私有林進行調查，經搜集其林木採運及工廠營運之各項作業成本包括工資、油料、耗材、設備折舊及運費等，並比較市面上太空包木屑售價，顯示其營運方式仍有利潤。

在竹林作業部分，本研究於新竹縣尖石鄉桂竹林地進行皆伐及擇伐之作業，並於4年後調查，在林分生長方面，皆伐作業區平均胸徑為2.58cm，竹桿高為6.14m，地上部生物量為30.58ton/ha；擇伐作業區平均胸徑為2.93cm，竹桿高為7.14m，地上部生物量為37.96ton/ha，各項林分屬性值擇伐作業均大於皆伐作業；且未伐採區之竹林趨於老化、幼齡竹較無法生長，不利竹林更新。

架空索集材可降低採運作業對環境之衝擊。圖為於台東縣延平鄉桂竹人工林以架空索進行集材作業。
Cable yarding technique can reduce the environmental impact for logging. The picture was the cable yarding for the Makino bamboo in Yanping Township, Taitung County.

The development of plantations thinning strategy and technique fulfilling the principles of forest certification (3/3)

Shyh-Chian Tang, Ping-Hsun Peng, Sheng-Hsin Su, Chung-Peng Hsu

Plantation thinning operation is the major part of multiple silviculture system. It can improve the volume and characters growth for preserved trees, and benefit the integrated carbon sequestration. The thinning operation was carried out in the 60 years old Taiwan Incense Cedar (*Calocedrus macrolepis* Kurz var. *formosana*) plantations located in Lienhuachih Research Center, Taiwan Forestry Research Institute, which had acquired the FSC forest certification. The investigation results indicated that the average DBH, tree height and forest growing stock were 26.0cm, 19.4m and 373m^3/ha respectively for thinned area. For the unthinned area, the values were 22.7cm, 18.2m and 346 m^3/ha respectively. Because of the increase of relative luminosity and porosity, the thinned area had a lot amount of natural renewal seedlings. And the forest landscape of multiple layered forests was established. The timber harvesting was an important issue for forest certification process. So it is an important work to develop the environmental friendly operational techniques. The skills include cable yarding for logging, avoiding from hurting the preserved trees while felling operation, etc. During the logging process, the following items including the environmental resources investigation, employee training, community impact survey and labor occupational safety training, etc. were implemented. On the other hand, the private management plantations which acquired the FSC forest certification was also investigated the cost of timber logging and factory operation. The items included wages, fuels, consumables, equipment depreciation and transportation charges, etc. Compared with the market price of sawdust space bag, it was still beneficial for the management type.

On the aspect of bamboo operations, the clear cutting and selection cutting were implemented in the Makino bamboo (*Phyllostachys makinoi* Hayata) stand located in Jianshi Township, Hsinchu County and the stand survey was carried out four years later. In terms of stand growth, the average DBH, stem height and above ground biomass were 2.58cm, 6.14m and 30.58 ton/ha respectively for clear cutting area and 2.93cm, 7.14m and 37.96 ton/ha respectively for selection cutting area. All the stand attributes for the selection cutting area were lager than those of clear cutting area. For the uncut area, the bamboo stand was inclined to ageing and the young bamboos were difficult to grow. The situation was unfavorable for bamboo stand reforestation.

臺灣林火週期與長期氣候指標關聯

潘孝隆

本研究整理日治時期總督府殖產局發布之林業統計、民國36年後之臺灣林業統計以及林業統計等多個官方紀錄來源，以建立日治時期森林被害統計至2018年林火長期紀錄。經過檢核各樣來源之紀錄，以及各紀錄間之一致性、清理資料內矛盾與誤植與登載闕漏後，整理出1914-2018年的火災面積與火災次數逐年統計，以及1959年後的逐月統計值。

經過資料清洗與標準化可以看出1922-1926、1954-1955、1963、1996、2000年為火災次數與面積為最相對高點。此跨百年的紀錄分屬日治、戰後以及2000年後國內引進ICS與施行災害防救法等3個時期，經過各時期標準化後，利用11年的林火次數與面積移動平均瞭解長期的發生趨勢，可以約略發現森林火災(圖1)分別為1949年前，1950年-1995以及1998-2016等三個時期等長週期的活躍時間，顯見長期而言應火災活躍與否，存在氣候背景。

太平洋年代際震盪之11年移動平均與火災面積以及次數之11年移動平均，存在相關性，顯示森林火活躍的趨勢與太平洋年代際震盪的趨勢有關(圖1)，意即火的活躍與否與背景氣候場的變化有關。利用地面13個測站的平均也可發現長期而言，降雨趨勢與森林火燒為反向關係(圖2)。

從NOAA的再分析資料亦可看出森林火燒活躍期(1949-1966年)的火季(12月至隔年3月，約位於太平洋年代際震盪冷相位期)，台灣附近地表位勢高較氣候平均態低，垂直速度為正值並較鄰近區高，地面降雨率較鄰近區域低(圖3)，因此區域的氣候背景場為冷乾且不利對流。另外如再以近年火燒較活躍的年份(1996年)為例，當年的春季的降雨率低且高壓籠罩，當年的火季開始時(11-12月，未示出)其高壓的情形較長期平均來的高。

綜合前述發現，可以推論臺灣森林火燒面積與次數的活躍時期，與太平洋年代際震盪有關，無論是再分析資料或是地面測站資料都顯示當時的氣候是有利於火燒發生。進一步，對照近年火燒的特定年分，可以發現也都有高壓較高、以及春雨期與火季的降雨率低，也因此可以發現，以10年尺度來看，乾濕變化週期的冷乾週期有助於火燒發生，如再進一步看年際的差異也有數年的乾濕差異，而1996年為近20年的高峰，1996春季為1995年反聖嬰年的延續，因此在氣候上我們可以推測出太平洋年代際震盪以及反聖嬰年都有助於森林火災容易發生，因此未來森林火災的減災與預備上，可以由此進行長期以及短期(年尺度)的準備。

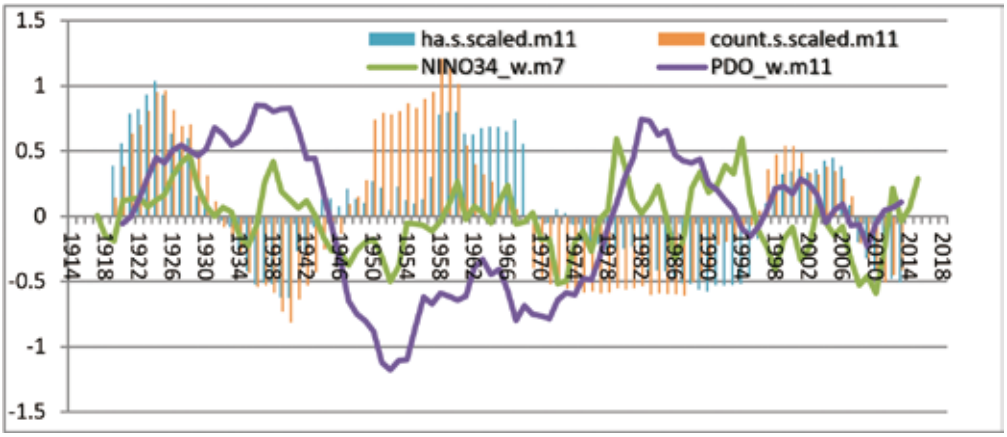


圖 1.　1914-2018 森林火災次數與面積以及太平洋年代際震盪(紫線) 11 年移動平均。
Fig 1.　1914-2018 11-year moving average of fire count and area burnt (ha) and PDO.

Taiwan forest fire periodicity and relation with long term climate

Hsiao-lung Pan

This study compiles forestry statistics released by the Bureau of Colonization of the Governor's Office during the Japanese rule period, Taiwan forestry statistics (after 1947), and forestry statistics from various official sources to establish a long-term record of forest fire count and area burnt from 1914 (the Japanese period) to 2018. After checking the records from various sources, cleaning the data for inconsistencies and missing entries, we compiled the annual statistics of fire area and number of fires from 1914 to 2018, and the monthly statistics after 1959.

After data cleaning and standardization, it can be seen that the years 1922-1926, 1954-1955, 1963, 1996, and 2000 are the most relative high points in terms of fire frequency and area burnt. After standardizing the data for each time period, the moving average of the number and area of forest fires over 11 years was used to understand the long-term trend. It is clear that there is a climatic background for fire activity over the long term.

The correlation between the 11-year moving average of Pacific Decadal Oscillation (PDO) and the 11-year moving average of fire area and frequency indicates that the trend of forest fire activity is related to the trend of PDO (Figure 1), meaning that fire activity is related to the change of the background climate field. Using the annual average rainfall of13 weather stations, we also found an anticorrelation relationship between rainfall trends and forest fires in the long term (Figure 2).

From the NOAA reanalysis data, it can be seen that during the active forest fire season (1949-1966) (December to March, around the cold phase of the PDO), the surface geopotential height near Taiwan was lower than the climate mean, the vertical velocity was positive and higher than the neighboring area, and the surface precipitation rate is lower than that of the neighboring area (Figure 3),so the regional climate background field was cold, dry and unfavorable to convection. For example, in the more active fire year in recent years (1996), the precipitation rate in the spring was low and high pressure prevailed, and the high pressure at the beginning of the fire season (November-December, not shown here) was higher than the long-term average.

In summary, it can be inferred that the active period of forest fire area and frequency in Taiwan is related to the PDO, and both reanalysis and ground station data indicate that the climate at that time was favorable for fire occurrence. Further, if we look at the specific years of fires in recent years, we can find that there are high pressure and low precipitation rates during the spring and fire seasons, and therefore we can find that on a about 10-year and the cool-dry cycle of the wet-dry cycle is conducive to the occurrence of fires. Therefore, we can deduce that the PDO and the La Nina year are both conducive to the occurrence of forest fires, and therefore long-term and short-term (annual scale) preparations can be made for future forest fire mitigation and preparation.

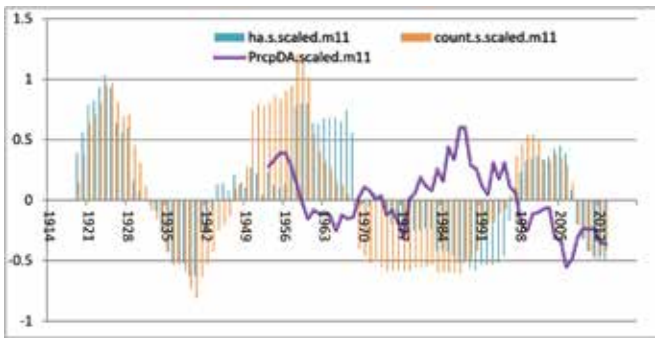


圖 2. 1914-2018 森林火災次數與面積以及氣象局觀測站降雨量 11 年移動平均。

Fig 2. 1914-2018 11-year moving average of fire count and area burnt (ha) and precipitation observed in 13 weather stations.

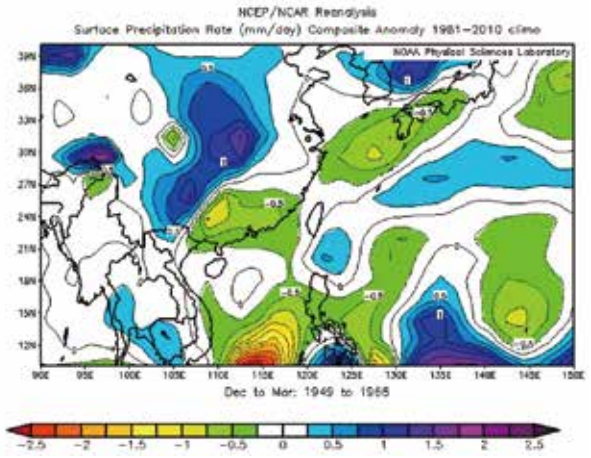


圖 3. 森林火燒活躍期地面降雨率(1949-1966年)。

Fig 3. DJFM surface precipitation rate in forest fire active phase (1949-1966).

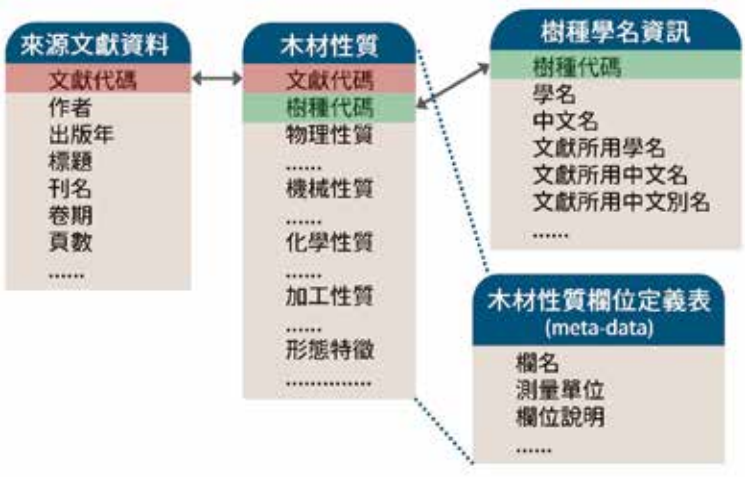
建構臺灣樹種之森林經營應用資料庫

蘇聲欣

臺灣之林學研究長期以來缺乏有關樹種的基礎功能特性或是模式參數之資料庫。前人研究成果散藏於文獻之中，亟待研究人員以系統性方法爬梳、整理、數據化過去之研究文獻，予以活化利用。

本研究自108年起執行兩年，已全面系統性搜尋國內1947年至2019年出版之主要林學研究文獻(包括期刊、研究報告、書籍圖鑑、技術報告等等)，累計瀏覽超過14,800筆文獻篇目。經盤點後，本研究針對「木材基礎性質」、「生長收穫模式與參數」兩項資料，廣泛收集樹種之研究文獻，研析文獻內容並萃取重要資訊，完成資料數據化。之後並整合不同資料來源之樹種學名、資料欄位定義，建置完成方便即用(ready-to-use)的資料庫。

目前，「木材基礎性質資料庫」已累積完成3,050筆資料、162個資料欄位，共約涵蓋到460個樹種。「生長收穫模式與參數資料庫」也已建構完成資料庫架構，目前收集了600筆資料、50個資料欄位，包含有19個樹種。本研究自110年度起將於另一計畫項下延續進行，繼續擴充、更新此兩項資料庫，並完成資料庫之最終整合與正規化作業。



木材基礎性質資料庫架構。
The database framework for the wood basic properties of tree species in Taiwan.

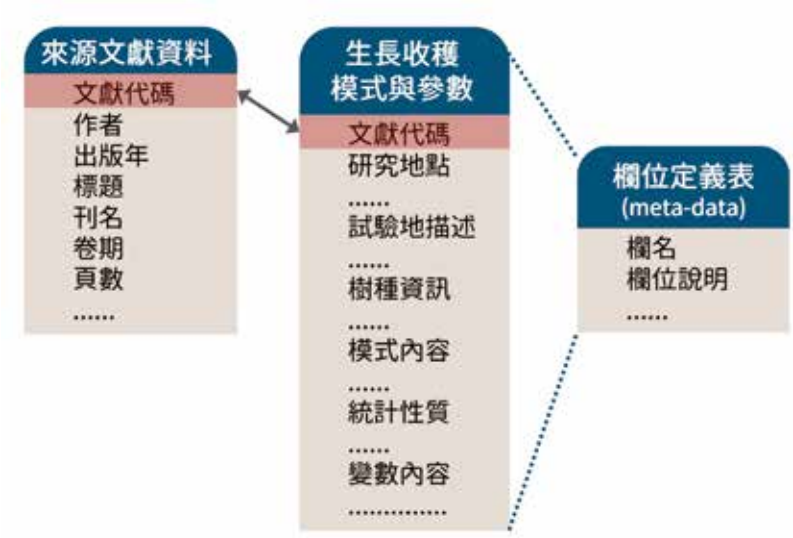
Building databases of the tree species in Taiwan for forest management application.

Sheng-Hsin Su

The forest science in Taiwan has long lacked databases of basic functional properties, models, and parameters of tree species. Previous research results are mainly recorded and scattered in the literature, awaiting researchers to collect, collate, and digitize the numerous research documents and then effectively utilize the derived knowledge.

This study systematically searched the major forest science literature published from 1947 to 2019, including journals, periodicals, books, technical reports, etc. In total, over 14,800 document items were examined. After that, this study was orientated toward collecting two kinds of tree species data: (1) wood basic properties; (2) models and parameters related to tree growth, yield, and allometry. This study widely collected, studied, and extract important information from relevant research documents for digitization. Finally, the data from different sources were integrated into two ready-to-use databases that have unified nomenclature (taxonomy) and definitions of data columns.

Currently, the database of wood basic properties contained 3,050 data records and 162 data columns, which were comprised of 460 tree species. The preliminary framework of the database of models and parameters related to the growth, yield, and allometry was constructed, and 600 data records and 50 data columns were collected, which were comprised of 19 tree species. This study will be continued under another TFRI science and technology program next year to expand and update the two databases and then complete the final integration and normalization of databases.



生長收穫模式與參數資料庫初步架構。

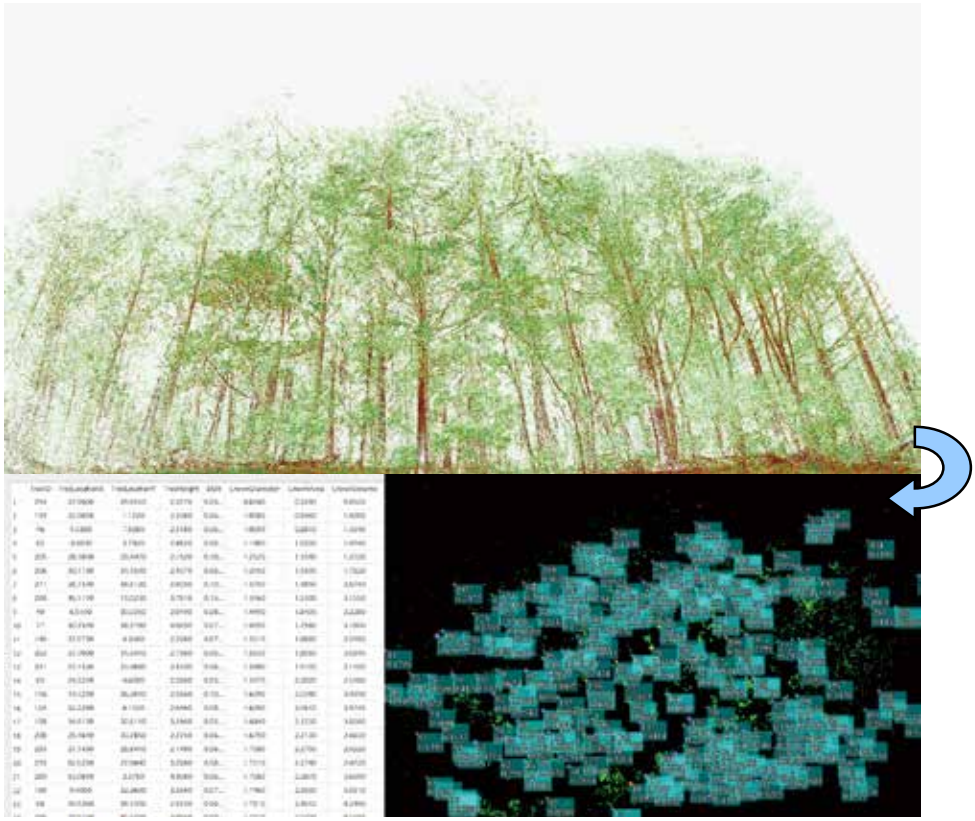
The preliminary database framework for the models and parameters related to the growth, yield, and allometry of tree species in Taiwan.

目標樹經營模式於長伐期永續木材生產規劃策略之應用

李隆恩

近年來，美、日等許多林業先進國家均陸續推行以培育目標樹為目的之森林經營模式，其概念係在森林生長過程中，運用營林及撫育技術將目標樹培育至預定之目標性態。其中，以生產用材為主的目標樹經營模式是透過選取目標樹(未來木)，並適期疏伐干擾目標樹生長之干擾木，以達成經營目標。此法適用於投資收穫期長，並以生產高價值木材為目標的營林方式，而此方式的核心工作則在於如何評估林分內各單株之生長情形與競爭狀況，以選擇恰當的目標樹及干擾木。由於臺灣的人工林多屬同齡純林，在樹種相同、年齡相近、環境相似的情況下，競爭作用對生長的影響更顯重要，因此，本計畫即是以地面光達蒐集林木空間與性態值資訊，並結合競爭指數評估競爭情形，以發展目標樹及干擾木之選木程序。

本計畫以BAL競爭指數(basal area in larger trees index)量化林木之競爭作用，並分析其與胸高斷面積平均生長量之關係，結果顯示模式配適之效果良好，並可有效解釋各單木之生長量。此一成果說明，利用競爭指數評估林分內各單株的競爭情形後，再結合光達掃描所獲取之林分空間資訊，即可將疏伐撫育之選木作業細緻化到單木層級，並依據各單株的競爭指數強度，排序成疏伐木之選擇順序。未來，運用此選木模式，即可以科學的方式規劃用材目標樹的疏伐撫育作業，加速培育優質之國產木材。



光達所蒐集之林木空間與性態值資訊，結合競爭指數可作為選木程序之參考。
Combining the spatial information from Lidar with competition index could be used as a reference to the thinning tree selection process.

Application of Crop Tree Management to Long Rotation Sustainable Timber Production Strategy

Li, Long-En

In recent years, advanced forestry countries have implemented Crop Tree Management (CTM) on forest management. Which is an applicable silvicultural technique used to enhance the performance of target individual trees during the forest growth process. The crop tree management based on timber production is a thinning technique used to promote the growth of crop trees through the removal of competing trees. This method is typically applicable to long rotation and high value timber producing. The core work of CTM is to evaluate the growth and competition of each individual tree, so as to identify crop trees and competing trees. Since most plantations in Taiwan are pure, even-aged stands, the effect of competition to growth is even more important. Therefore, the purpose of this project is to collect spatial and characteristics of individual trees by ground-based Lidar and evaluate the competition by index, to develop the selection model of CTM.

We quantified the competition of each trees by BAL index (basal area in larger trees index) and analyzed the association with the average increment of the basal area. The result shows the model fits well and effectively explains the growth of each individual trees. It indicates that by combining the competition index with spatial information, the thinning tree selection can be refined to the individual level. Moreover, according to the competition index, the order of thinning trees could be determined. In the future, applying this selection process, it will be able to plan thinning model of CTM to improve the high-quality domestic timber production.

叢生型竹材收穫機械化效益評估

林裕仁

國內目前有亟需大量竹材發展竹加工產業規模之需求，然叢生竹之供給量少與作業成本高，始終無法迎合業界營運所需，因此，本計畫主要目標在提升叢生型莿竹與長枝竹的伐採作業效率，以蒐集國外現有生產林木伐採高效率自動化機具資料進行評估，並對國內現有莿竹與長枝竹等叢生型竹材伐採作業生產力與作業成本進行現地調查分析，提出可以配合國內竹材伐採作業現況可行之機具，提出研發方向與合作建議，做為日後引進該機具之評估資料。本計畫原規劃經專業貿易商洽詢國外先進科技高效率林木伐採機具製造廠商後，以租賃機具方式，邀請製造廠商技師來臺進行實機示範，惟因2020年全球新冠病毒疫情隔離政策關係，導致無法順利依據原規劃執行，僅能先行請專業貿易商與製造廠商多方溝通與蒐集資料方式進行先期評估。另也透過與當地廠商與資深竹農及相關業者的交流討論方式，交流實務經驗提供貿易商轉達製造廠商，為日後疫情隔離管制措施舒緩，為實機示範作準備。未來若有業者投資需求，可提供媒合與技術支援。因引進國外先進科技高效率林木伐採機具具有解決目前現行伐採作業技術落後之問題，亟具發展潛力，為確實引進機具實體與應用，後續有待更多政策支持與支援方能落實提升莿竹與長枝竹產量，振興當地竹產業的目標。

叢生型的莿竹目前砍伐仍以效率低的人工作業為主，無法滿足產業需求，亟需引進現代化高效率機具，提升收穫作業效率。

The current thorny bamboo (*Bambusa stenostachya* Hackel) harvesting is dominated by low-efficiency manual operations, which entirely cannot meet the bamboo industry demand. To promote the harvesting efficiency, the high-efficiency modern machinery and tools to be introduced is imperative.

Harvesting efficiency assessment on simulated mechanized of sympodial bamboo

Yu-Jen Lin

To develop industry scale for bamboo processing industry, there are always a large demand on bamboo culm in Taiwan. However, the supply of sympodial bamboo current is low and operation cost is high, which has never been able to meet the industry demand. Therefore, the goal of this project is to improve the harvesting efficiency of sympodial bamboo: thorny bamboo (*Bambusa stenostachya* Hackel) and long-branch bamboo (*Bambusa dolichoclada* Hayata), through an assessment by collecting the related information of high-efficiency automation equipment for forest harvesting on existing products overseas. The work also conducted the investigation and analysis around the productivity and operating costs of the existing domestic harvesting operations on-site in order to find feasible machinery and tools for domestic bamboo harvesting operations, simultaneously, to propose development directions and suggestions for future introduction of the machinery. The original plan of this project was to consult a foreign advanced technology and high-efficiency forest harvesting equipment manufacturers through professional traders, to rent equipment and to invite their technicians come to Taiwan to make a demonstration. Unfortunately, due to the global COVID-19 epidemic and quarantine regulation, the technicians could not come to Taiwan in accordance with the original plan. The project only could ask the traders communicated with manufacturers and collect more information to make preliminary evaluation. In addition, the work also made exchanges and discussions with domestic manufacturers, bamboo farmers and related industries, to exchange practical experience so that could provide traders more information to the manufacturers to prepare future practical demonstrations, so as the epidemic isolation control measures to ease in the future. It could solve the current backward bamboo harvesting operation and has huge development potential if the foreign advanced technology and high-efficiency forest harvesting equipment were introduced to Taiwan. We could provide matching and technical support if there is investment demand from the industry. However, to revitalize local bamboo industry on utilization of thorny bamboo and long-branch bamboo through actually equipment introduction and application, it is necessary to need more policy support in the future.

森林永續經營策略及理論架構

王培蓉、婁安琪、嚴晟瑋

臺灣森林常有缺乏適當撫育管理、生態劣化、林木生產不佳，及危害國土保安功能等負面情形。再加上多數私有林面積過小、投入成本與風險過高、從業者高齡化及獲益不如預期等問題。對於林產業長期發展來說，亟需思索適宜臺灣森林的永續經營策略。近代歐洲盛行的近自然林經營和美國學者提出的複雜適應系統，皆陸續提倡應依循自然，並重視森林生態系統的永續性。而在鄰近的日本則有自伐型林業，主張藉由長伐期、多次小面積弱度疏伐，來生產品質較佳之大徑木。

本研究整理了近自然林經營、複雜適應系統及日本自伐型林業之概念、方法，並依森林權屬評估適宜臺灣之經營策略。結果發現國、公有林可參酌近自然林經營概念，小面積擇伐、疏開劣化的人工林，營造異齡、複層且具樹種多樣性之近天然林，如此一來，可以兼顧當地原有的生態系統及木材生產。私有林則可借鏡自伐型林業，由林農自行管理、在地居民或林農共同管理、或委託給當地核心林農或森林組合進行作業；盡量使用小型機械、車輛及作業道，並由政府補貼相關費用，降低投資成本及環境破壞；鼓勵林農發展副業，以解決山村老齡化與人口流失等社會結構性問題，進而促進森林資源的生產性與自然運行的正向和諧關係，達到真正的森林永續經營。

日本十津川村內有84%是私有森林，目前持續以提升木材生產、營造針闊葉混合林等方式，推動林業六級產業化。
84% of Totsugawa Village in Japan is private forest. At present, it is continuing to promote the six-level industrialization of forestry by improving wood production and creating mixed coniferous and broad-leaved forests.

Strategy and theoretical framework of forest sustainable management

Pei-Jung Wang, An-Chi Lou, Chen-Wei Yen

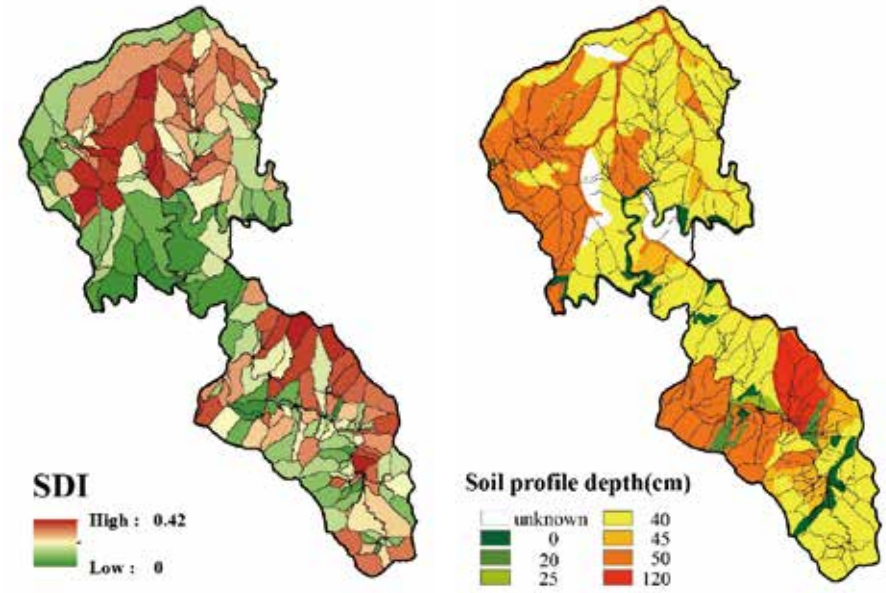
Taiwan's forests often suffer from negative situations such as lack of proper tending management, ecological degradation, poor forest production, and endangering national security functions. Most of the private forests are too small, the input costs and risks are too high, the practitioners are aging and the benefits are not as expected. For the long-term development of the forest industry, it is urgent to think about sustainable management strategies suitable for Taiwan's forests. However, both close-to-natural forest management and complex adaptive system have successively advocated the need to follow nature and attach importance to the sustainability of forest ecosystems. Since the rise of Zibatsu forestry in Japan, it is advocated to produce large-diameter wood with better quality through long-term logging and multiple small-area weak thinning.

This research collated the concepts and methods of close-to-natural forest management, complex adaptive systems and Japanese Zibatsu forestry, and evaluated management strategies suitable for Taiwan based on forest ownership. The results found that national and public forests can consider the management concept of close-to-natural forest management, small areas selective cutting, open up degraded plantations, and create forests of different ages, multiple layered and species diversity. In this way, both local ecosystem and wood production could be taken into consideration. Private forests can take advantage of Zibatsu forestry, managed by forest farmers, jointly managed by local residents or forest farmers, or entrusted to local core forest farmers or forest portfolios for operations. Use small machinery, vehicles and forest roads, and subsidize related expenses by the government to reduce investment costs and environmental damage. Encourage forest farmers to develop sideline businesses to solve social structural problems such as aging and population loss. Promote the positive and harmonious relationship between forest production and nature, and achieve true sustainable forest management.

植生覆蓋對邊坡穩定功效之探討

陸象豫

本計畫以林業試驗所六龜試驗林之衛星影像、數值高程模型(digital elevation model，DEM)、數值地表模型(digital surface model，DSM)、土地利用圖及實地土壤調查資料，藉地理資訊系統及遙感探測等技術，萃取該試驗林植生覆蓋、地形濕潤及樹冠高度等指數，以獲取土壤有效深度指標(soil depth index，SDI，為上述三指數的乘積)，再建立土壤深度指標及實測土壤深度間之線性關係式，進而推估該試驗林全域的土壤深度。六龜試驗林土壤深度(Sd) 與指標間的關係式為：Sd = 1076.4*SDI-96.649，其相關係數達0.86，顯示藉容易獲得的集水區環境因子，可有效推估土壤深度。獲知土壤深度分布後，再建立六龜試驗林坡度與土壤深度及坡度與植被高度間的關係，由此種關係以及以往的研究成果推估坡面上植被載重與土讓層載重間的比例關係，以評估植物覆蓋對邊坡剪應力之影響。結果顯示，六龜試驗林在坡度超過55% (≒28.8°)時，其土壤深度隨坡度增加而迅速遞減，而林冠高度在坡度84% (≒40.0°) 以上時，隨坡度增加而遞減。由於植生覆蓋的載重與土壤的載重在絕大部分的坡面上的比率均甚低，且風吹襲所產生的力矩作用，對森林地亦不顯著；而植物的蒸發散、根系的網結土壤、減緩地表沖蝕、增加孔隙率及入滲率等作用，可有效降低淺層崩塌的可能性，因而植生覆蓋對邊坡穩定的影響可謂利大於弊。



(a) Distribution of SDI　　(b) Distribution of soil depth

六龜試驗林土壤有效深度指標 (SDI) 及所推估的土壤深度分布圖。
The distribution of SDI and soil depth for the LEF.

Study on the effectiveness of vegetation cover for slope stability

Shiang-Yue Lu

This project used geographic information technologies to analyze digital data such as satellite images, digital elevation model, digital surface model to extract the vegetation coverage indexes, topographic wetness indexes and canopy elevation indexes of the Liukuei experimental forest (LEF) to obtain the effective soil depth index (SDI, the product of above mentioned index), and then established a linear relationship between the soil depth index and the measured soil depth to estimate soil depths of the entire experimental forest. The relationship between the soil depth (Sd) and the SDI of the LEF is: Sd = 1076.4*SDI-96.649, with a correlation coefficient of 0.86, which demonstrated that using the relatively easy-to-obtain environmental factors can effectively estimate the soil depth. Based on the estimated soil depth, this project further established the relationship between slope gradient and soil depth and vegetation height for the LEF. From those relationships and previous studies then further estimated the proportional of vegetation loads to the soil loads to evaluate the influence of increased shear stress due to vegetation cover on slope. The results showed that when the slope gradient of the LEF exceeded 55% (≒28.8°), its depth decreased rapidly with the increase of the slope, and the height of the forest canopy also decreased when slope gradient is above 84% (≒40.0°) with the increase of the slope gradient. Because the ratio of the load of plant cover to the load of soil on most slopes is very low, the load generated by the weight of vegetation is not significant in forest lands. The evapotranspiration of plants can reduce both of soil pore water pressure and weight of the slop, the networked soil by roots can reduce surface erosion, and vegetation can create favorable hydrological conditions such as increasing porosity and infiltration rate, etc., which can effectively reduce the possibility of shallow collapse. Therefore, the impacts of vegetation cover on slope stability are having more advantages than disadvantages.

多納溫泉溪崩塌地植被復育之研究(3/3)

陳永修、鍾安晴、周富三、林文智

2009年8月的莫拉克颱風重創台灣南部，造成高雄市茂林區的多納林道嚴重損毀，並形成許多面積大小不一的崩塌地。本研究的主要目的在調查多納溫泉溪流域崩塌地的植物組成與結構，建立崩塌地植被演替的途徑。此外也將不同耐陰性的樹木小苗種植在不同光度的崩塌地，期能提高苗木在崩塌地惡劣地形下的成活率、增加崩塌地的樹種多樣性，並擬定加速崩塌地演替之策略。

本研究在形成10年之1公頃崩塌地樣區內，共記錄到69種的樹木，合計3694株，包含陽性樹木25種2794株，數量占全部樹木的75.64%；耐陰樹木共有35種862株，數量占全部樹木的23.34%。樣區內也記錄到45種樹苗，合計772株，包含陽性樹苗9種216株，數量占全部樹苗的27.98%；耐陰樹苗共有39種556株，數量占全部樹苗的72.02%。

由上述結果得知，陽性樹木比例(75.6%)明顯高於耐陰樹木(23.3%)，主要樹種為先驅樹種白匏子(*Mallotus paniculatus*)及山黃麻(*Trema orientalis*) (兩者占所有樹種總數之64.7%)，可見該崩塌地大致上仍處於演替早期階段。而耐陰樹種例如臺灣山桂花(*Maesa perlaria* var. *formosana*)在灌木層中占有重要比例，且苗木層的耐陰樹種比例更達72%，越接近森林下層，耐陰樹種的優勢度越為增加，顯示該崩塌地有逐漸向演替中期推進的趨勢。

本研究在多納崩塌地1公頃樣區內栽植12種苗木，在出栽2年後，平均苗高介於25~136 cm，其中無患子(*Sapindus saponaria*)、臺灣欒樹(*Koelreuteria henryi*)、杜英(*Elaeocarpus sylvestris* var. *sylvestris*)的存活率(皆在97%以上)及一年間相對高生長率(皆大於38%)皆很高，可見在崩塌後自然恢復10年之崩塌地進行人為苗木出栽，可獲得良好之復育成效。

本研究之多納崩塌地已形成10年，由本圖可看出部分區域已形成由先驅樹種構成之次生林，然而部分區域仍為裸露，呈現鑲嵌式的地貌。

The Duona landslide site in this study has been formed for 10 years. From this figure, it can be seen that some areas have formed secondary forests composed of pioneer tree species, but some areas are still bare, showing mosaic-like landscape.

A study for the vegetation restoration on the landslide site at the Duona Hot Springs River Basin

Yung-Shui Chen, An-Ching Chung, Fu-shan Chou, Wen-Chin Lin

Typhoon Morakot lashed southern Taiwan in August 2009, causing severe damage to the Duona forest road in Maolin District, Kaohsiung City, so as the formation of many landslide areas of various sizes. The main purpose of this research is to investigate the plant composition and structure of the landslide site in the Duona Hot Springs River Basin, and to establish a pathway for vegetation succession in the landslide site. In addition, we plant seedlings of different shade tolerance trees on the landslide site with different light condition, to improve the survival rate of seedlings under the harsh terrain of landslide site, increase the diversity of tree species in landslide site, and suggest strategies to accelerate the succession of landslide site.

In this study, a total of 69 species of trees were recorded in a sample area of 1 hectare of landslide site that was formed 10 years ago, with a total of 3694 trees, which including 25 species, totally 2794 trees of shade-intolerant trees that accounting for 75.64% of all trees; in the other hand, including 35 species, totally 862 trees of shade-tolerant trees that accounting for 23.34% of all trees. There are also 45 species, totally 772 individuals of seedling recorded in the sample area, including 9 species, totally 216 individuals of shade-intolerant seedlings, accounting for 27.98% of all seedlings; in the other hand, including 39 species, totally 556 individuals of shade-tolerant seedlings that accounting for 72.02% of all seedlings.

According to the above results, the proportion of shade-intolerant trees (75.6%) is significantly higher than that of shade-tolerant trees (23.3%). The main tree species are the pioneer tree species, *Mallotus paniculatus* and *Trema orientalis*, the two accounted for 64.7% of the total number of all tree species, which shows the landslide site is still in the early stage of succession. However, shade-tolerant species such as *Maesa perlaria* var. *formosana*, occupies an important proportion in the shrub layer, and the proportion of shade-tolerant species in the seedling layer reaches 72%. The closer to the underground layer of the forest, the more the dominance of shade-tolerant species, which shows that the landslide site has gradually advanced to the middle stage of the succession.

In this study, 12 species of seedlings were planted in a 1-hectare plot of the Duona landslide site. Two years after planting, the average seedling height was 25~136 cm. Among the 12 species, the survival rates of *Sapindus saponaria*, *Koelreuteria henryi*, and *Elaeocarpus sylvestris* var. *sylvestris* (all above 97%) and the relatively high growth rate in one year (both greater than 38%) are very high. Thus, planting seedlings in the landslide site that has formed 10 years could have a good restoration effect.

森林驗證與生態系服務支付運作機制之研究(3/3)

吳孟珊

生態系統服務支付(payment for ecosystem services, PES)政策是透過補償個人或社區的方式，促使其採取行動來增加或提供生態系統服務。其核心思想是由土地所有者或管理者為生態系服務的使用者或受益者，在結合直接激勵措施與有條件的合約下，提供某些生態系統服務，或支持特定的森林管理策略，從而產生理想的生態系統服務和環境成果，以及有效的保育資金配置。

本研究去年度以封閉式問卷進行調查，發現林農皆選擇最高金額作為最低總補償價格，無法評估合理的生態系服務補償價格，故今年度就各項實際造林成本進行調查，了解現行獎勵造林政策是否具足夠經濟誘因吸引林農參與造林。研究結果發現以20年期進行造林，平地造林的平均造林成本為673,635元/ha，大於現行20年的獎勵標準60萬元；非平地造林的平均造林成本為497,895元/ha，小於現行獎勵標準。就除草、施肥與管理次數觀之，平地造林可歸類為積極型經營，非平地造林則歸類為放任型經營。若屬放任型經營的林農，獎勵造林制度應有極大的經濟誘因，若屬積極型的林農，造林獎勵金仍然利不及費。

平地與非平地造林的平均造林成本(元/ha)

項目	整地費用	新植費用	除草費用	施肥費用	肥料費用	補植費用	修枝費用
平地造林	68,818	22,573	10,548	7,155	5,359	16,750	19,312
非平地造林	97,714	30,571	10,906	13,003	2,025	10,958	20,000

*除草、施肥、肥料、補植及修枝等費用為每公頃每次作業所需成本。

Research on the Operating Mechanism of Forest Verification and Payment for Ecosystem Services (3/3)

Meng-Shan Wu

The payment for ecosystem services (PES) policy is to compensate individuals or communities to take actions to increase or provide ecosystem services. The core idea is that landowners or managers serve users or beneficiaries of ecosystem services, combining direct incentive measures and conditional contracts, to provide certain ecosystem services, or to support specific forest management strategies, thereby produce ideal ecosystem services and environmental results, as well as effective conservation fund allocation.

This study conducted a closed questionnaire survey last year and found that forest farmers all chose the highest amount as the lowest total compensation price, and it was impossible to evaluate a reasonable compensation price for ecosystem services. Therefore, this year we conducted a survey on various actual afforestation costs to understand whether the current incentive afforestation policy has sufficient economic incentives to attract forest farmers to participate in afforestation. The results of the study found that the average afforestation cost of afforestation in a 20-year period is 673,635 NTD/ha, which is greater than the current 20-year reward standard of 600,000 yuan; the average afforestation cost of non-flat afforestation is 497,895 NTD / ha, which is less than the current reward standard. In terms of the frequency of weeding, fertilization and management, flat-land afforestation can be classified as active management, and non-flat-land afforestation can be classified as laissez-faire management. The rewarding afforestation system should have great economic incentives for laissez-faire forest farmers, but not enough for active forest farmers.

Average afforestation cost of flat and non-flat afforestation (NTD/ha)

Program	Land preparation	New plant	Weeding	Fertilization	Fertilizer	Replanting	Pruning
Flat land afforestation	68,818	22,573	10,548	7,155	5,359	16,750	19,312
Non-flat land afforestation	97,714	30,571	10,906	13,003	2,025	10,958	20,000

*The cost of weeding, fertilizing, fertilizer, replanting and pruning is the cost per hectare per operation.

山村鑲嵌地景對鳥類群聚及多樣性之影響

王相華、傅淑瑋、葛兆年、施郁庭

學者研究顯示，山村的鑲嵌地景具有高生物多樣性的維持功能，此一傳統土地管理模式近年來廣為日本生態學者所推崇，並引介、推廣至許多國家，包括臺灣。本研究於北海岸3處山村(分別位於新北市萬里、金山、三芝區)的3種棲地類型(農墾地、森林、森林邊緣)各設置3個樣區，探討山村地景對鳥類多樣性及群聚造成有何種影響。經由2年定期(每2個月1次)調查，資料分析結果顯示，不同類型棲地(農墾地、森林、森林邊緣)的鳥種數及隻數均有顯著差異，農墾地樣區的鳥類種數及隻次均明顯高於森林樣區。非度量多維尺度分析(NMDS)結果顯示，三種不同棲地類型的鳥種組成各自成群，相異度分析(ANOSIM)亦達顯著差異，主要受到森林、旱田、水田地景特徵的影響。山村鑲嵌地景的森林、森林邊緣及農墾地各有其鳥類組成特色與保育價值。

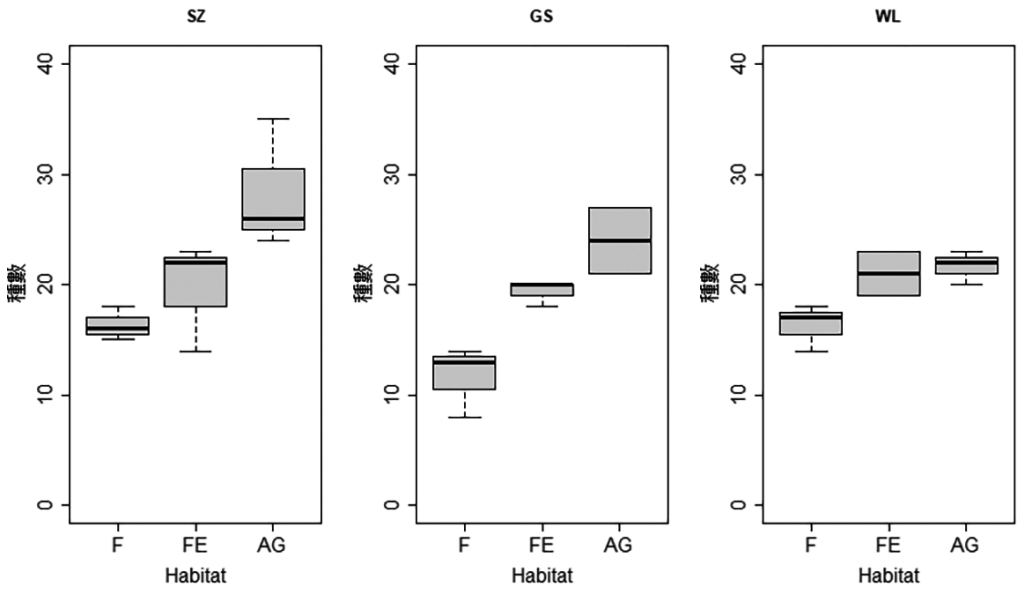


圖 1. 鳥種數量於山村中三種棲地類型的盒鬚圖。橫軸F、FE、AG 為三種棲地類型 (F: 森林、FE: 林緣、AG: 農墾地)、縱軸為種類數量。三個村莊代碼：SZ、GS、WL分別表示三芝、金山、萬里。

Fig 1. Species boxplot in three habitats among three mountain villages. X-axis "F", “FE”, “AG” means three habitats Forest, Forest Edge and Agriculture. Y-axis presents total species amount. The title of sub-figure “GS”, “SZ” and “WL” means mountain village.

The Effects of Mountain Village Landscape on Biodiversity

Hsiang-Hua Wang, Shu-wei Fu, Chao-Nien Koh, Yu-Ting Shih

The mosaic landscape of satoyama (mountain village) in Japan had been reported that it has the function of maintaining high biodiversity. This traditional land management model has been widely promoted by ecologists in recent years and introduced to many countries including Taiwan. We surveyed bird communities in three farmlands, forests, and forest edges habitats in each of three coastal mountain Villages (located in Wanli, Jinshan and Sanzhi District, New Taipei City), northern Taiwan every two months for two years, and aimed to elucidate the effects of mountain village mosaic landscapes on bird diversity and bird community. The results show that there are significant differences in bird diversity in three different types of habitats (agriculture, forest, forest edge) in mountain village. The bird diversity in the farmland habitat were significantly higher than those in the forest habitat. The results of NMDS and ANOSIM analysis showed that the bird species composition of three habitat types were significant differences, it means that each of the forest, forest edge and farmland habitats in mountain village have their own bird composition characteristics and conservation values.

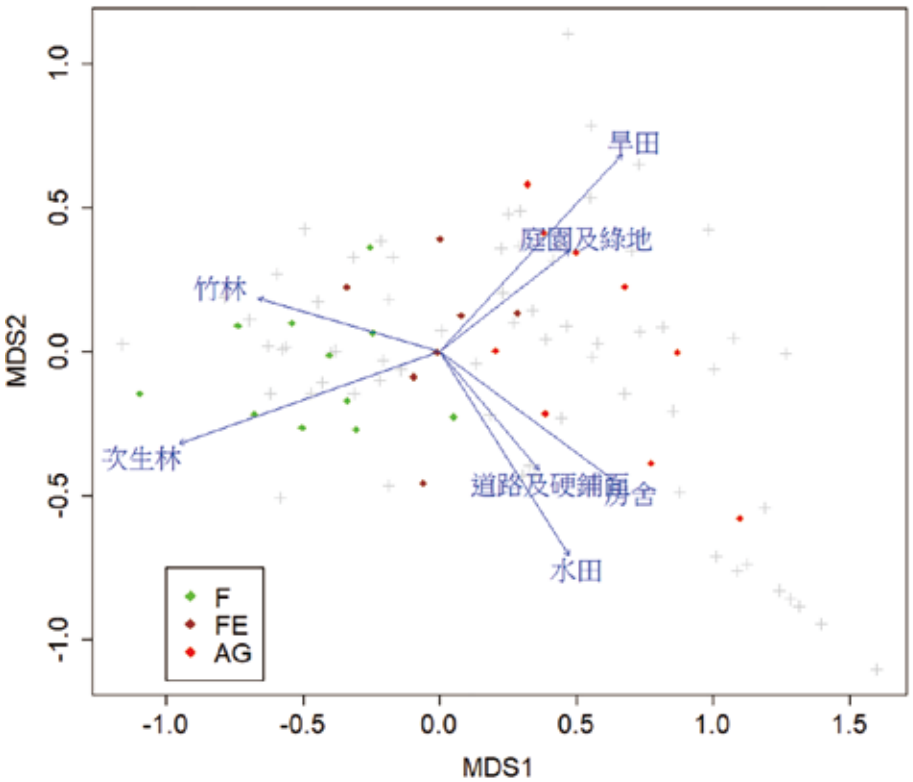


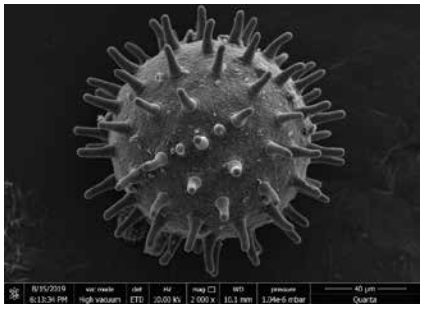
圖 2. 鳥類族群的非度量多維度分析與環境條件適配。輸入資料為鳥類族群數量，主要控制的地景特徵為a) 次生林 b) 水田 c) 旱田。十符號為74種鳥類投影於非度量多維度座標軸的分布位置。藍色箭頭顯示地景類別與鳥類群聚之間的關聯強度。

Fig 2. NMDS analysis of observation birds with landscape. Input communality of birds. The major fitted landscape is a) secondary forest, b) paddy and c) Upland field. Grey cross (+) present 74 birds species projected in NMDS axes. Blue arrow means strength of landscape-units correlation with bird community.

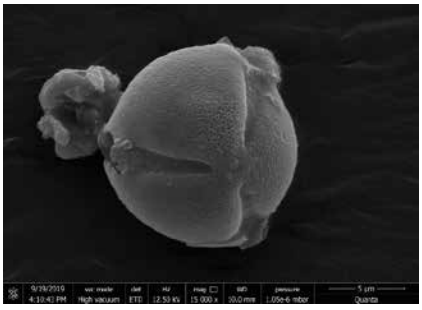
森林授粉蜂類及其對林木授粉功能之研究

陸聲山、葉文琪、謝昀臻

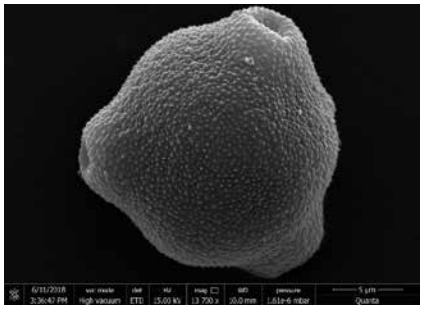
授粉是維持開花植物多樣性所必需的生態系統服務，與糧食生產和食品安全密切相關。森林生態系中訪花的授粉蜂類能幫助植物授粉，促進植物的繁殖；因此，授粉蜂類多樣性也是維持植物遺傳多樣性的保障。2020年1月至12月，我們於福山研究中心採集之開花植物種數達208種，並已拍攝其中101種的花粉SEM影像，以供後續花粉樣本鑑定比對所用。我們藉由掃網與黃盤採集的調查，並比對林業試驗所昆蟲標本館福山地區採集的有螯蜂類標本，已整理出名錄清單一份，共記錄福山研究中心有螯類膜翅目昆蟲98種。包括地蜂科(Andrenidae) 6種、蜜蜂科(Apidae)15種、青蜂科(Chrysididae) 3種、分舌蜂科(Colletidae) 1種、銀口蜂科(Crabronidae) 6種、隧蜂科(Halictidae) 15種、切葉蜂科 (Megachilidae) 6種、蛛蜂科(Pompilidae) 3種、土蜂科(Scoliidae) 5種、細腰蜂科(Sphecidae) 5種、胡蜂科(Vespidae) 33種。根據生態功能區分，其中授粉性種類有43種，狩獵性47種，擬寄生性8種。授粉蜂種類主要以蜜蜂科及隧蜂科為主，分別各有15種，狩獵蜂則以胡蜂科33種最多。另外，我們針對野牡丹屬植物進行野外目視的授粉昆蟲及行為觀察，總共記錄了1,289次的訪花紀錄，至少含有隸屬於7個目之63種昆蟲。野牡丹的花具有異型雄蕊，亦即半數雄蕊花絲短且藥隔極短，另一半雄蕊花絲較長且藥隔延長。這兩型花藥皆僅在末梢處開一個小圓孔，只有具備振動授粉(buzz pollination)能力的蜂類才能有效率地採得內部的花粉。根據本年觀察結果，顯示*Lasioglossum*和*Maculonomia*兩屬的隧蜂會頻繁拜訪野牡丹並表現出振動授粉的行為，因此我們認為牠們可能是福山研究中心野牡丹屬植物的重要授粉媒介昆蟲。本研究建立福山研究中心林木花粉影像資料庫及授粉蜂類的基礎名錄，可供後續蜂類採集之花粉樣本的鑑定比對，以探討授粉蜂類授粉功能與森林生態系的相關性。



牧野氏山芙蓉 *Hibiscus makinoi*



米碎柃木 *Eurya chinensis*



楊梅 *Myrica rubra*

大葉溲疏 *Deutzia pulchra*

掃描式電子顯微鏡下觀察的花粉粒影像。
Images of the pollen grains observed with a scanning electron microscope (SEM).

Research on the pollinating aculeates and their function in forest ecosystem

Sheng-Shan Lu, Wen-Chi Yeh, Yun-Chen Hsieh

Pollination is an ecosystem service essential to maintaining the diversity of flowering plants, and is closely related to food production and food safety. Flower-visiting aculeates in forest ecosystems can help pollinate flowers and promote plant reproduction. The diversity of pollinating aculeates is also a guarantee of maintaining the genetic diversity of plants. In 2020, 208 species of flowering plant species were collected in Fushan Research Center from January to December; among these, 101 species have their pollen grains scanned with scanning electron microscope (SEM). There were totally 98 species of aculeates catalogued from Fushan Research Center via comparing the specimens collected by net-sweeping and yellow pantrap methods with the voucher specimens preserved in Insect Collection of the Forest Research Institute. The catalogued aculeates include 6 species of Andrenidae, 15 species of Apidae, 3 species of Chrysididae, 1 species of Colletidae, 6 species of Crabronidae, 15 species of Halictidae, 6 species of Megachilidae, 3 species of Pompilidae, 5 species of Scoliidae, 5 species of Sphecidae, and 33 species of Vespidae. According to their ecological functions of these aculeate, 43 species are pollinators, 47 are predators, and 8 species are parasitoids. The pollinators are mainly Apidae and Halictidae, each with 15 species, and predators are mostly Vespaidae with 33 species. In addition, we conducted field investigations by witness observation on the insect pollinators for the shrubs of the genus *Melastoma* (Myrtales: Melastomataceae). A total of 1,289 visits to the *Melastoma* flowers were recorded for at least 63 insect morphospecies belonging to seven orders. There are heteromorphic stamens in the *Melastoma* flowers, half of the stamens have short filaments and extremely short connectives; the other half has longer filaments and extended connectives. Both types of anthers have only one small round hole at each of their tips. Only specific bees with vibrating ability can collect the inside pollen grains efficiently. According to the observations, the bees of two genera, i.e. *Lasioglossum* and *Maculonomia* (Halictidae), frequently visited and performed vibrating behavior (buzz pollination) on the flowers, and are considered to be the dominant pollinators of *Melastoma* in Fushan Research Center. The aim of this research is to establish an image database of flowering plant and to compile a preliminary list of pollinating aculeates in the Fushan Research Center. The database and list can then act as a reference for subsequent identifications of both pollinating aculeates and the pollen they collected to explore the correlation between the function of pollinator and forest ecosystem.

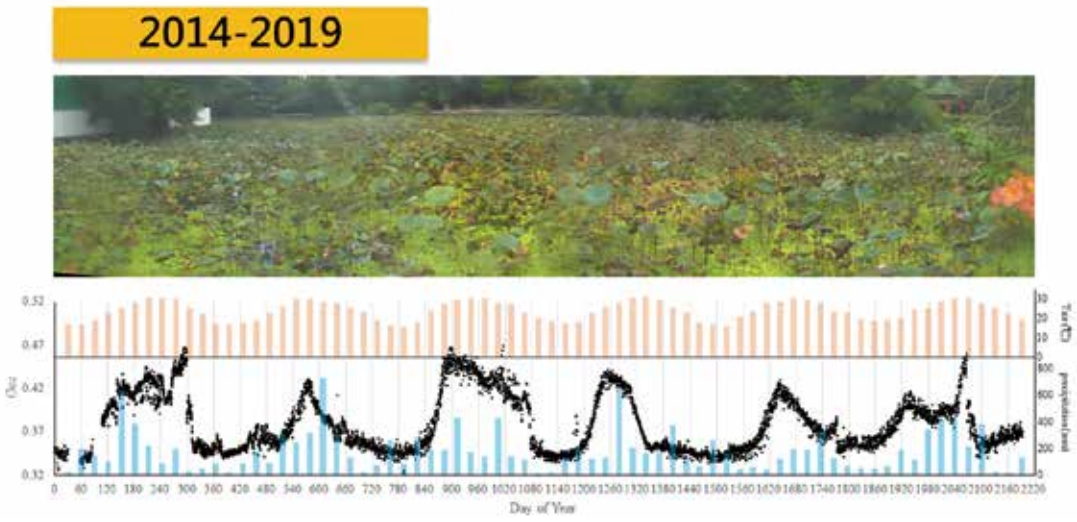
數位物候學(e-phenology)的監測與應用

Monitoring and application of e-phenology

張勵婉、余尚鈺、鄭美如、陳建文
Chang Li-Wan, Yu Shang-Yu, Jeng Meei-Ru, Chen Chien-Wen

本計畫以遠程數位監測植物物候的技術，將臺北植物園荷花池2014-2019年所拍攝的影像，利用PhenoCam軟體進行自動判試與分析。此方法強化影像辨識及可信度，並提升資料獲取的便利性與正確性，解決傳統物候學仰賴密集的人工觀察與記錄的調查限制。

The study uses the technology of remote digital monitoring of plant phenology to automatically test and analyze the images of lotus ponds in Taipei Botanical Garden from 2014 to 2019 using the PhenoCam software. This method enhances image identification and reliability, and improves the convenience and accuracy of data acquisition, and solves the limitations of traditional phenology, which relies on intensive manual observation and recording.



利用PhenoCam計算2014-2019年台北植物園荷花之綠色度坐標的物候變化。台北測站(466920台北)之氣溫為橘色長條圖、雨量為藍色長條圖，黑點為綠色度坐標(Green Chromatic Coordinate (GCC))。

Using PhenoCam to calculated phenological changes of the Green Chromatic Coordinate (GCC) of lotus in Taipei Botanical Garden during 2014-2019. The temperature bar is orange, the rainfall bar is blue, and the black dots are GCC in the Taipei meteorological station (466920 Taipei).

珍貴老樹健檢技術平台建立

Establishment of a technical platform for the health inspection of precious old trees

傅春旭、張東柱、林介龍
Chuen-Hsu Fu, Tun-Tschu Chang, Chieh- Lung Lin

本計畫以台灣北、中、南、東四個地區為調查標的，各地區選擇一個縣市作為調查範圍。2017以彰化縣作為調查範圍，共計調查63棵老樹。2018年以新竹市作為調查範圍，共調查91株列管老樹。2019年以高雄市為調查範圍，共調查441棵老樹。2010年間以花蓮縣作為調查範圍，共調查32處珍貴老樹，共計105棵樹木。為符合森林法樹保專章的規定，工作大致分為兩部分，一、為收集老樹的社區訪談及文史資料，紀錄老樹對社區或是提報單位之意義、文史訪問及樹齡。二、為現地調查：針對受提報老樹樹種釐清，測量樹高及樹胸圍等，建立樹木基本資料表。同時針對提報樹木之健康情形做基本健康檢查，每一調查單株建立一份普查資料表，可作為日後管理參考依據。所檢查的老樹皆未受褐根病感染，但有幾處受普查之老樹因與疫區相近故有感染疑慮；縣府已將之列為防治標的進行防除作業，以避免珍貴綠色資源受到危害。除了長良國小編號47楓香，因樹齡及各種客觀量測數據未達列管標準，同時提報單位亦未能提供該樹對於學校及社區之特殊性，故未達列管標準；其餘104棵皆達列管標準，是周圍民眾及管理單位特定保留的老樹，其中72株管理單位同意依據森林法列管。對於列管的老樹花蓮縣府也陸續改善其環境條件，給予友善的發展空間，定期健檢及病蟲病防治讓老樹與社區共存共榮。

This project takes four cites from northern, central, southern, and eastern Taiwan as the survey targets. In 2017, Changhua County was used as the scope of investigation, and a total of 63 old trees were investigated. In 2018, Hsinchu City was used as the scope of investigation, and a total of 91 old trees were investigated. In 2019, Kaohsiung City was used as the survey area, and a total of 441 old trees were surveyed. In 2010, Hualien County was used as the survey area, and a total of 32 sites were surveyed, for a total of 105 trees were surveyed. In order to meet the provisions of the special chapter on tree protection of forest law, the work is roughly divided into two parts. One is to collect community interviews and cultural and historical data of old trees, and record the significance and cultural history of old trees to the community or reporting unit. The other part is on-site investigation: clarify the reported old tree species, measure tree height and tree bust, etc., and establish basic tree data tables, which can be used as a reference for future management. None of the old trees inspected were infected by brown root disease, but several old trees under general survey were suspected of being infected because they were close to the disease area; Hualien county government has listed them as control targets for prevention and control operations to avoid precious green resources endangered. Except for the No. 47 Liquidambar in Chang-Liang Elementary School, the age of the tree and various objective measurement data did not meet the management standards, and the school also failed to provide the particularity of the tree to the school and the community, therefore, it did not meet the management standard;The remaining 104 trees all meet the management standard. These old trees are specially reserved by the surrounding people and management units. Among them, there are 72 old trees that management units agreed to be listed in accordance with the forest law. The Hualien County Government has also successively improved the environmental conditions of the listed old trees , giving them friendly development space, and regularly health checkups and pest control so that old trees can coexist and prosper with the community.

銅門國小老樟樹之調查。
Investigation of old cinnamon tree in the Tong-Men Elementary School.

樹木健康管理及資源應用研究

張東柱、徐孟豪、傅淑瑋、傅春旭

調查樹木上木材腐朽菌種類以應力波檢測內部都有腐朽的問題，且由於老樹都具有一定樹齡，腐朽蟲蟻入侵的機會也大，長期以往形成大型的樹洞或是大部分的木材組織腐朽而失去支撐能力，經常是在樹木仍能正常生長下，因外力或無法支撐樹身重量而導致傾倒或是斷裂。因此對於已知的腐朽應盡快進行防治，施行樹木外科手術，對於未知的內部腐朽，可以依靠一些精密儀器輔助調查，但重要的是調查後是否有積極去處理，才是樹木健康管理的重點。調查入侵種龍眼雞的擴散範圍，2018-2019年主要集中於新北市八里、五股、淡水及台北市士林、北投等地，2020年增加基隆及台北市南區的通報紀錄，其與本土種渡邊氏東方蠟蟬在寄主植物資源上並無發現明顯競爭排擠效應。都市發展造成自然棲地減少及破碎化，也降低原生物種多樣性。為了探討都市不同環境間鳥類多樣性分布，我們利用eBird公民科學資料檢視台北地區原生鳥種與外來鳥種在環境梯度上的分布。透過計算鳥類種類數及個體數，探討原生鳥種分布是否隨都市化程度增加而遞減?外來種是否隨都市化程度增加而遞增?初步篩選2019年3~6月間清單並定義濕地、森林、農地、都市綠地、都市草地、學校及公用設施等6類土地覆蓋型後，可用於分析種類數之清單1499筆，個體數1437筆。以廣義加成模式分析，探討土地覆蓋型、調查時間、調查持續時間及地點等變因對外來/原生鳥類多樣性之影響，結果顯示原生鳥種在濕地及農地呈現較高的種類數及個體數，外來鳥種則在農地及都市草地有較高的種類數及個體數。在都市環境內，濕地及農地是保育原生鳥類的重要土地覆蓋型。此外，整體清單中，外來種出現的比例達78%，顯示台北市外來鳥種入侵情況很普遍，六類土地覆蓋類別中，以森林環境出現外來種的種類及數量較少。

樹木健康管理及資源應用研究調查。
Investigation of tree healthy management and application of resources.

Study on tree healthy management and application of resources

Tun-Tschu Chang, Meng-Hao Hsu, Shu-Wei Fu, Chuen-Hsu Fu

Investigations of wood decay fungi were associated with rotten woods detected by Abotom instrument. For some aged trees, wood cavities were caused by wood decay fungi and some kind of insects which would weaken the mechanical supporting strength of trees and induce to the trees becoming hazardous. By Abotom detection, the tree conditions of wood cavities would have better understanding. Treatments for the rotten and cavity trees will be suggested and applied which will provide a better management of the aged rotten trees. Investigation on the spread of the invasive species, *Pyrops candelaria*, was conducted from 2018. Before the end of 2019 we found that this species was mainly distributed in Bali, Wugu, Danshui (New Taipei City), Shilin and Beitou (Taipei City), etc. In 2020, the notification records of Keelung and Southern District of Taipei City were also reported. So far, no significant competition for host plant resources was found between this invasive species and the native species *Pyrops watanabei*. Urbanization results in loss and fragmentation of natural habitats, generally decreasing diversity of native species. In order to explore the distribution of birds in urban environments, we used eBird citizen science data to examine the diversity of native and exotic bird species between six land cover types in Taipei city. We tested whether urbanization decreased native bird diversity or increased exotic bird diversity. We filtered the checklists from eBird database during 2019 March to June, and defined their land cover types, including wetland, forest, agriculture land, urban green space, urban grassland, school and public utilities. We calculated species richness and total number of individuals to represent exotic and native bird species diversity. A total of 1499 checklists were included in the analyses of species richness, and 1437 checklists in the analyses of total number of individuals, respectively. We used Generalized Additive Models to examine the effects of land cover types location, season and survey duration on the native/exotic bird species diversity. Results reveals that the diversity of native birds was higher in wetland and agriculture land, and that of exotic birds was higher in agriculture land and grassland. Wetland and agriculture land were important land cover types for conserving native bird species in urban areas. In addition, exotic bird species occur in 78% checklists, indicating that the invasion of exotic bird species in Taipei City is very common. Among six land cover types, fewer exotic species occur in forest environments.

樹木生態效益管理研究

詹為巽、林俊成、王培蓉

為評估都市樹木之管理成本以及可帶來之生態系服務效益，以及了解都市民眾對於都市樹木效益與缺點之認知。本計畫蒐集都市樹木養護相關原料、工項等價格資料，分析都市樹木管理之成本。都市樹木生態系服務效益部分，參考目前國際常用之i-Tree Eco系統，分析其所使用之「都市林效益模型(Urban Forest Effects Model, UFORE)」，探討各種效益分析所需之資料及相關參數，再針對其中「空氣汙染效益」及「碳效益」模型之分析方法進行探討，釐清可進行本土化之參數。分析結果發現樹木之「材積推估式」為估算樹木效益之重要因子，且影響估算結果之準確性，因此本計畫以台北市樟樹、楓香及茄苳等3種常見樹種為例，抽樣並運用地面光達(LiDAR)調查此3樹種樣木之地上部材積，建立此3樹種適用於台灣都市環境之材積推估式。同時本計畫一併蒐集台北市路樹之樹種、胸高直徑等資料，以及生態系服務效益分析模型所需之氣象、空氣污染等基礎環境資料，做為未來估算都市樹木生態系服務效益之基礎資料。而都市民眾對於都市中樹木所帶來之優缺點的感受與認知，以及對於都市樹木保護的看法等部分，本計畫透過問卷針對台北市居民進行調查。結果顯示臺北市居民認為都市樹木最重要之效益為「碳吸存」，其次為「釋放氧氣」；而認為最嚴重的缺點為「病蟲害影響生活品質」及其次「樹木遮蔽產生陰暗角落等社會安全問題」，並有約84%之受訪者願意支付額外之費用以保護都市樹木，平均之願附金額約為820元。

都市樹木提供多樣的生態系服務功能。
There are many kinds of ecosystem services provide by urban trees.

Study on the ecosystem services management of trees

Wei-Hsun Chan, Jiunn-Cheng Lin, Pei-Jung Wang

In order to evaluate the management costs and the ecosystem service benefits of urban trees, and to understand the residents' perception of the benefits and problems of urban trees. This study collects information on the prices of materials and work related to urban trees maintenance and analyzes the costs of urban trees management. In the section on the ecosystem service benefits of urban trees, we analyzed the Urban Forest Effects Model (UFORE) with reference to the i-Tree Eco system, which is commonly used internationally, and explored the data and parameters required for analyses. Therefore, this project used three common tree species in Taipei, including *Cinnamomum camphora*, *Liquidambar formosana* and *Bischofia javanica*, as examples, and apply LiDAR to investigate the above-ground volume of these three species to establish the allometric models for volume of these three species in the urban environment of Taiwan. This study also collects the species and DBH of Taipei's street trees, as well as basic environmental data such as meteorology and air pollution required for the ecosystem service benefits analysis model, which provide for estimation of ecosystem service benefits of urban trees. Furthermore, this study conducts a survey through questionnaires to conduct residents' perception of the benefits and problems of urban trees in Taipei city. The results show that the residents of Taipei City believe that the most important benefit of urban trees is "carbon sequestration", followed by "release of oxygen"; and the most serious deficiencies are problems such as "the quality of life affected by diseases and pests" and secondly, social security such as "shaded trees and dark corners". And about 84% of the respondents are willing to pay extra to conserve urban trees. The average amount of willingness to pay is about $820 NTD.

建構樹木健康與微生物族群關聯性研究

劉則言

土壤為樹木生長所必須，其質地、溫度、濕度、肥力等，都會影響到樹木的生長情況。此外，土壤中的豐富微生物族群，也與樹木的健康狀況息息相關。這些棲息在土壤或植物根系附近的微小生命，包含真菌、細菌、線蟲等，有些能夠透過與樹木根系共生關係的建立，來促進樹木的生長。然而不幸的是，亦有一群稱之為植物病原菌的微生物，會對樹木根系進行為害，造成樹木的生長勢衰弱。都市樹木的生長，同樣受到都市土壤環境中微生物族群的影響。面對有別於自然環境的都市林土壤，其中存在著何種樣態的微生物族群，以及如何透過土壤中有益微生物族群的建立，來促使都市樹木的健康，為本研究探討之核心主題。本研究先針對國內常見的都市樹木病害發生情形進行評估，並從中篩選作為土壤微生物族群研究之標的。經由微生物分離培養技術的建立，成功從健康和感病樹木的立地土壤中，分離出相對應的細菌與真菌共40株，進一步分析這些菌株為潛在的樹木病原菌或益菌，以作為評估國內都市林土壤健康之參考。此外，隨著定序技術的進步，我們也透過分子檢測與核酸定序的方式，了解土壤與樹木樣本中的病原菌和其他真菌存在情形。本研究期能經由對都市林土壤微生物的了解，提出符合國內都市林樹木生長所需的土壤微生物族群組成，並經由都市林土壤之健康管理，促使國內都市樹木之生長健康，以提高都市樹木的生態效益。

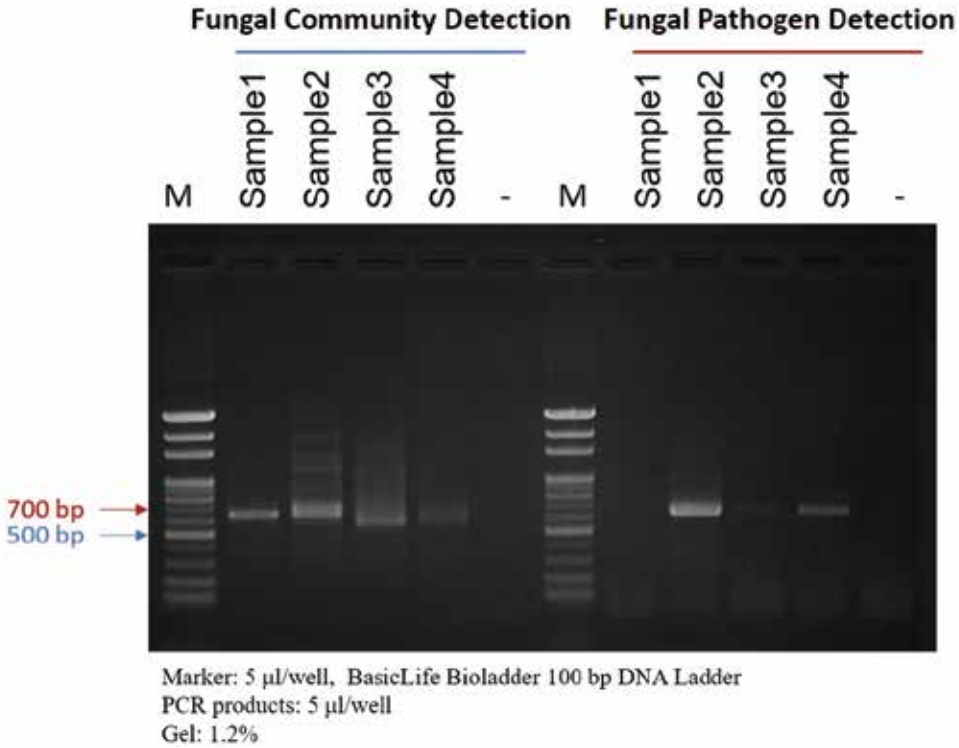


圖 1. 都市林土壤微生物族群存在情形監測。
Fig 1. Investigation of the microbial communities in the soil of urban forest.

Establishment of the correlation between the health of trees and the microbial communities

Tse-Yen Liu

Soil is one of the essential elements for tree growth. It's texture, temperature, humidity, fertility, etc. would affect the growth of trees. Additionally, thousands of microbial communities in the soil are closely related to tree health. Some of the tiny microorganisms, including fungi, bacteria, nematodes, etc. could establish symbiotic relationships with the root systems to promote the tree growth. Unfortunately, there are some other groups of microorganisms called as plant pathogens which would harm the roots of trees and cause abnormal growth. Trees growing in the urban areas are also influenced by the microbial communities in soil of their planting sites. Since the microbial communities are quite different from nature, the major topic of our study is to investigate the health management of trees in the urban area through establishing the benefit microbial communities in the soil. We first evaluated the most important urban tree disease in our country and select some of the disease happening regions as our research plots. We further investigated the microorganisms through isolated and cultivated method and successfully identify 40 bacterial and fungal isolates from the planting sites of healthy and diseased trees. Those isolates are used for further estimating their potential beneficial or harm effects of trees. Besides, as the sequencing techniques getting progress, we also used the molecular detection and DNA sequencing to identify the pathogens and other microorganisms in the soil. The study expects to draw a picture of the beneficial microbial communities which are essential for the growth of trees in our urban areas. We also look forward to promote the health and ecological benefits of trees through the soil management research in the urban areas.

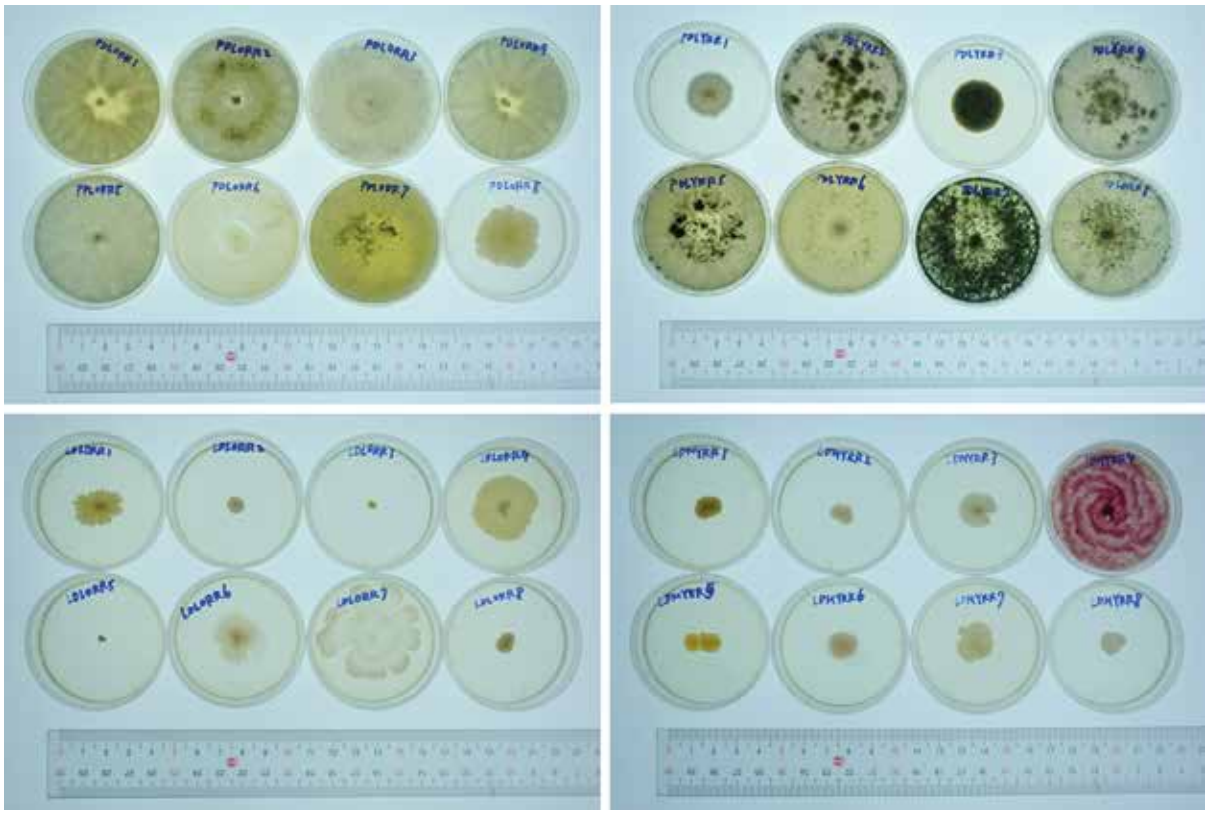


圖 2. 都市林微生物分離結果。

Fig 2. Isolation of the microorganisms from soil of urban forest.

有害生物友善環境管理技術(荔枝椿象)

徐孟豪、蔡宇平、汪澤宏、吳孟玲

針對荔枝椿象的成蟲族群季節消長，從2018年開始進行調查研究，取樣寄主植物包含臺北市行道樹或綠地空間的荔枝、龍眼、無患子及臺灣欒樹，本研究也探討族群動態與光週期及氣候因子的關係。調查發現這種每年一個世代的椿象，其族群動態和光週期具有明顯相同的趨勢；而且此種成蟲的生殖滯育可能影響其族群動態，然而調查也發現暖冬和梅雨雨量二者對於當年族群大小來說是負面因子，因此造成2019年3月至12月的荔枝椿象族群數量明顯較2018年同期為低。在龍眼上發現的荔枝椿象明顯比其他3種寄主植物上的蟲數多。本研究對於掌握更佳防治時機具有參考價值，例如在六月族群高峰以後，成蟲趨向於離開原本若蟲時期的寄主植物特別是荔枝、無患子及臺灣欒樹；冬季曾在一些龍眼樹的葉背發現生殖滯育成蟲成團聚集。另，在臺灣欒樹上荔枝椿象交配對的數量高峰總是比其他3種寄主植物晚出現，交配對甚至持續出現到夏天。本研究也發現連續降雨雖然可能因為大幅增加田間荔枝椿象罹染蟲生真菌的機會，進而容易發現僵死掛在樹上的椿象屍體，然而此時卻不利於卵寄生蜂的釋放，最佳釋放時機應該落在荔枝椿象在春初打破越冬開始交配之後。釋放含有寄生蜂的卵片必須避開降雨外，更要有防範螞蟻捕食卵的相關措施，故採取直接釋放小蜂成蜂而非釋放被寄生卵片是較佳的措施。

冬天在龍眼葉欉中發現許多生殖滯育的荔枝椿象成蟲。
Aggregations of adults, *Tessaratoma papillosa*, in reproductive diapause were found in the longan leaves in winter.

Study on the environmentally-friendly approach to insect pest managements: take the litchi stink bugs for example

Meng-Hao Hsu, Yu-Ping Tsai, Joseph Wang, Meng-Lin Wu

A study from the beginning of 2018 in Taipei City was conducted to investigate the population dynamics of adult litchi stink bugs, *Tessaratoma papillosa*, on the trees for roadsides and urban green space including *Litchi chinensis*, *Dimocarpus longan*, *Sapindus mukorossi* and *Koelreuteria henryi*, and the relationships between it and the photoperiod or climatic factors. We found that the pattern of the population dynamics of this univoltine bugs was significantly the same trend with the photoperiod. Moreover, the reproductive diapause of the adult stink bugs might play important role in the population dynamics. However, we also found that the warm winter and early summer rainy season were negative factors to the population size of stink bugs. There are significantly more adult bugs in 2018 than that in 2019 when compared the same periods from March to December of the two years. In comparison among four species of trees, there were significantly more stink bugs on longan than other species of trees, especially during diapause. The results of this study provide great strategic value for the decision of timing for better control of this invasive pest to Taiwan. This study also found that continuous rainfall may greatly increase the chance of litchi stink bugs being infected with entomogenous fungi in the field and it is easy to find dead stink bugs hanging on the tree, but this is not conducive to the release of egg-parasitic wasps for biological control. The best time to release the biological control agents should better begin after the termination of diapause of lychee stink bugs in late winter and start mating in early spring. The release of egg-parasitic wasps should avoid rain, and measures must be applied to prevent ants from preying on eggs containing parasitic wasps. Therefore, it is a better measure to directly release adult wasps in the field instead of releasing parasitic eggs.

冬天在一片龍眼葉下發現七隻生殖滯育的荔枝椿象成蟲。

Seven adults, *Tessaratoma papillosa*, in reproductive diapause were recorded under a leaf of longan in winter.

里山地景之評量基準與指標(3/3)

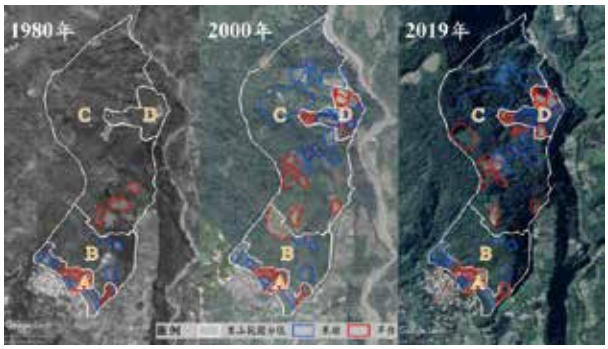
董景生

臺灣淺山農林產業交會的山坡地及原住民保留地範圍面積廣達26萬公頃，具有發展里山產業的高度潛能。本計畫以山村及周圍農林產業為對象，以里山倡議三種作法與五項關鍵觀點為基礎，進行資源盤點，評估山村社區是否具有發展里山產業的潛力，並確認所需要的基本資訊，如傳統生態知識、生態環境特性、土地利用變遷、產業發展歷史與現況、社會與經濟資料及其他相關各種資料與圖資等討植生覆蓋對邊坡穩定功效，做為發展潛力評估使用。

指標建構則採用多準則評估法中的「模糊德爾菲法」進行指標篩選；並透過學術與實務二方面的17位專家問卷進行調查，利用max-min及三角模糊數計算出共識值、最後選定專家門檻值來進行指標篩選與比較。本研究最後共獲得六大準則，分別為A生物多樣性、B在地生物資源的生產與利用、C生態系統功能與保護、D自然資源的知識與創新、E治理與社會公平、F生計與社會福祉，下屬共計28條評估指標。而學術與實務專家最大認定差異則來自E治理與社會公平。

此外，透過文獻回顧、參與式工作坊等質化方法，將公眾參與式地理資訊系統 (Public Participation Geographic Information System, PPGIS) 應用於里山地景變遷分析。以參與式評估法調查過往地景的變遷、分析里山地景的變遷驅動力，提升相關里山計畫、政策、及學理論辯的深廣度與品質。

以GIS圖層進行里山社區篩選。
The selection of Satoyama community by using GIS.



里山地景變遷圖-望鄉社區。
The changes of Satoyama landscape – kalibuan community.

Criteria and indicator of Satoyama landscape

Gene-Sheng Tung

In Taiwan, the total scale of agroforestry foothill zones and indigenous reserves reaches 260,000 hectares, and this has a great potential for the development of Satoyama Industry. This project selects candidate mountain villages to establish an evaluation database based on the three approaches and five critical points of Satoyama Initiative. The list of data, ranging from traditional ecological knowledge, environmental characteristics, the changes in land use, the historical and current industrial development, social, economic, and other related information and charts. The effectiveness of vegetation cover for slope stability will be used for evaluation purpose.

The indicators are selected and constructed using the "fuzzy Delphi method" of the multi-criteria evaluation method; and are surveyed through expert questionnaires from the Academic and practical experts. After evaluation of the value and exclusion of extreme values, calculation of triangular fuzzy numbers and consensus values, each expert's threshold value is selected to take 6 as the threshold. There are total six major aspects, they are: A biodiversity, B local biological resources production and utilization, C ecosystem functions and protection, D natural resources knowledge and innovation, E governance and social equity, F livelihoods and social well-being and covering 28 evaluation indicators in this structure. The most significant difference between academic and practical experts is that E governance and social justice.

Moreover, through qualitative methods such as literature review and participatory workshops, the Public Participation Geographic Information System (PPGIS) is applied to Satoyama Analysis of l and scape changes. Investigate changes in past landscapes and analyze driving forces for changes in Satoyama landscapes with a community-based participatory method to enhance the breadth and quality of relevant Satoyama plans, policies, and academic theories.

公眾參與式地理資訊系統社區工作坊。
Workshop of Public Participation GIS.

社區參與里山地景指標評估。
Community participation in the evaluation of Satoyama landscape.

里山生產地景植物多樣性與傳統知識保存之研究(1/1)

陳建帆、廖敏君、董景生

本研究於花蓮縣富里鄉豐南社區友善耕作梯田，調查不同生產地景之植物多樣性，並在梯田範圍內比較不同管理行為對植物多樣性差異，來探討低度與友善的生產擾動行為對多樣性之影響。並且調查花蓮富里鄉豐南阿美族以及南投信義鄉望鄉布農族傳統生態知識，並將資料分成食用、農事、狩獵、居住/生活空間、醫療、歲時、育樂、衣飾、天氣預測、編織及象徵等11種用途類別。生物多樣性調查結果顯示水田與休耕地植物多樣性明顯高於旱田及廢耕地，其中又以廢耕地植物多樣性最低，主要原因為缺水後偏好潮濕環境的植物消失，而強勢外來種入侵後形成高優勢度。因此建議以友善耕作搭配短期輪流休耕方式分配水圳水源耕作，應有助於營造多樣棲地；同時維持低度生產擾動行為，避免單一外來種佔優勢，能保存較高植物多樣性。傳統生態知識調查結果於花蓮富里鄉豐南吉拉米代部落，調查39科82屬96種植物，所利用的植物中為臺灣原生種有56種，外來種有40種。蒐集147筆植物用途資料，資料數量最多的類別為食用類別65筆資料，以主食、野菜、水果等食物為主；南投信義鄉望鄉部落，調查22科39屬43種植物，所利用的植物中為臺灣原生種有30種，外來種有13種。蒐集50筆植物用途資料，資料數量最多類別為狩獵類別18筆資料。原住民的傳統生態知識是該部落居民長期與自然間互動而產生的知識系統，具有文化保存及自然保育的意義，建立發展里山產業所需的基本資訊，需與部落建立良好關係及了解其傳統生態知識及土地利用，並有助於改善目前法律與原住民傳統領地的矛盾，促進原民共管政策推行。

說明太魯閣櫟及灰背櫟的生態分布。

Study on Plant Diversity and Traditional Knowledge Preservation in Satoyama Production Landscape (1/1)

Chien-Fan Chen, Min-Chun Liao, Gene-Sheng Tung

We investigate plant diversity in different production sites on friendly farming terraces fields in Fengnan, Fuli, Hualien, Taiwan, and compare the differences in plant diversity between different management within the terraces to explore the effects of low and friendly production disturbance behavior on diversity. We investigate the traditional ecological knowledge of Ami people in Fengnan, Fuli Township, Hualien, and Bunun people in Xinyi, Nantou, Taiwan. Survey data classified into 11 categories: food, agriculture, Hunting, residential/living space, medical treatment, age, entertaining, clothing, weather forecast, weaving, and symbolism. The results of the biodiversity survey show that the plant diversity of the water field and fallowing field is significantly higher than that of dry and abandoned fields. The plant diversity of abandoned fields is the lowest because the plants that prefer humid environments disappear with water shortage. Then, strong alien species form a high advantage after the invasion. We suggested that allocating water resources in a friendly field and short-term rotational fallow help create various habitats. At the same time, maintaining low production disturbance behavior, avoid single alien species dominance can preserve higher plant diversity. The traditional ecological knowledge of indigenous people is the knowledge system produced by the long-term interaction between the inhabitants of the tribe and nature, which has the significance of cultural preservation and conservation. Traditional ecological knowledge of indigenous people is the essential information to develop the Satoyama industry. It is necessary to establish a good relationship with the tribe and understand their traditional ecological knowledge and land use. It helps to improve the current contradiction between the law and the traditional territories of the aborigines and promote the implementation of the aboriginal co-management policy.

吉哈拉艾水梯田

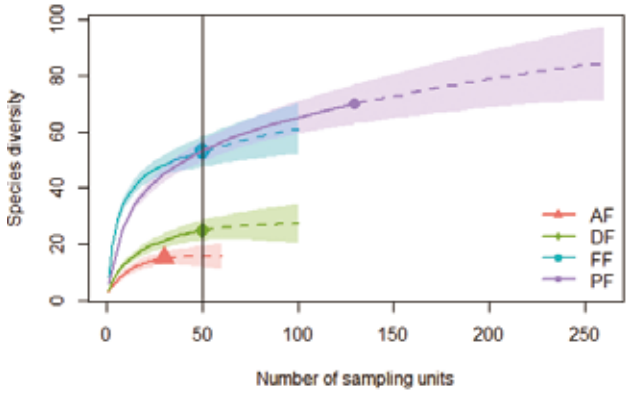


圖 1. 以稀釋曲線分析比較不同生產管理對植物多樣性差異，AF為廢耕地、DF為旱田、FF休耕地、PF為水田。

Fig 1. Using rarefaction curve analysis to compare plant diversity in difference management. AF: abandoned field, DF: dry feild、FF: fallow field、PF: Paddy field.

蓮華池林園療癒之規劃研究

陳舜英、傅昭憲、許原瑞、姚曉蓓

本所蓮華池研究中心位於臺灣中部低海拔山區，周邊有森林、沼地、旱地等不同土地利用與經營型態，環境保持良好，可作為山村林園療癒發展場域與療程規劃基地，使環境保護與產業發展相輔相成。本計畫主要執行成果包括：

一、蓮華池療癒基地資源調查：蓮華池試驗林地各項環境資源，包括不同類型步道、房舍建築場域、戶外活動場域等，依其特色建立調查資料庫。

二、里山產業活動及社區需求調查規劃：(1)進行社區需求訪談或調查，瞭解社區現況及需求；(2)邀請國內相關領域專家及在地民宿業者、地方產業及社區居民進行焦點座談，以瞭解社區產業狀況及面臨問題，並進行意見溝通；(3)訪談鄰近產業業者，瞭解各業者的現有資源及未來規劃，並邀請參與研究中心的各種培訓課程，逐步轉型發展屬於在地的療癒活動。

三、林園療癒嚮導之教育訓練：培訓對象以生態導覽志工、鄰近地區休閒遊憩、長照機構、心理諮商相關單位業者等，共完成107小時的林園療癒嚮導課程訓練，共培訓出10位優秀的在地林園療癒嚮導。

四、林園療癒行程規劃：完成蓮華池全區6條療癒步道的發展規劃，可根據參與者之需求、活動內容與人數靈活運用，目前已辦理6場次林園療癒體驗活動。

蓮華池的林園療癒路線結合園藝五感體驗，展現科技無法取代的獨特性，不但提供現代人降低焦慮、紓壓的機會，還可提升在地產業發展，不同於其他地方的森林療癒性質，成為臺灣獨樹一格的療癒場域。

經由嚮導帶領體驗不同的森林感受。
Experiencing different feelings in forest of the trainees with guider.

Study of the Forest- horticultural Therapy in Lienhuachih Research Center

Shun-Ying Chen, Chao-Hsien Fu, Yen-Ray Hsui, Hsiao-Pei Yao

Lienhuachih Research Center is located in a low-altitude mountainous area in central Taiwan, where is surrounded by forests, marshes, dry land, and provides different types of land uses and management. The good environment condition can be used as the forest- horticultural healing site, and promotes local industrial development of the mountain villages. Results of this project in the academic year are as follows:

1. Natural resources investigation of the Lienhuachih forest-horticultural healing site: Various environmental resources in the Lienhuachih experimental forests, including different types of trails, outdoor sites and inside the buildings for activities, etc were investigated and constructed, and the database information were established.
2. Satoyama industrial activities and community needs survey planning: (1) Community current situation and residents needs interviews were conducted and surveyed. (2) The different domain experts, community guest house dealer, local industries and community residents were invited and discussed their current situation and problems. (3) Neighboring industry operators were interviewed and understood their resources and future plans. Meanwhile, we invited them to participate some kinds of training courses, and let them gradually develop local forest- horticultural healing activities.
3. Education and training of forest- horticultural therapy guides: The trainees from ecological guide volunteers, neighboring recreation area, long-term care institutions, psychological counseling related companies, etc people had received the 107 hours of forest-horticultural therapy guide courses, and totally ten excellent healing guiders were certificated.
4. Forest-horticultural healing itinerary planning: Completed the 6 healing trails establishment in Lienhuachih area, where can be used flexibly according to the needs of participants, the content of activity and the number of people. Up to now, 6 sessions of forest-horticultural healing experience activities have been handled.

The forest healing route combined with the five senses of gardening in the Lienhuachih have been showing their unique technology and cannot be replaced by any other site and program. It not only provides modern people with opportunities to reduce anxiety and relieve stress, but also enhances the local business development. We would like to say that the Lienhuachih area with forest has become a unique excellent healing field in Taiwan.

林園療癒產品之研發

森林化學組 洪昆源

林園療癒(Forest-gardenly therapy)，其機轉源自於放鬆-內分泌-神經-免疫力，放鬆後由於內分泌達到平衡，逐次影響神經和提升免疫力中的殺手細胞(Kill cell)。隨後又建立各項細胞和生化活性之篩選平台，包括林園療癒對美白、神經、皮膚、防蚊之活性成分和免疫力及內分泌都可以快速分析。

本研究為重要成果為完成開發氣霧療癒裝置-乾式兩用擴香器：燒煙式的薰香粉和防蚊香環常造成健康和環境的問題。乾式擴香改良自古老的煎香，它是一種緩慢釋放氣味和香氣的方法，又不使環境很潮濕，在注重環保的今天，空污的意識抬頭，保護呼吸道，避免肺癌的發生，要從減少PM2.5的接觸開始，而且本裝置可以充分利用所有具有療癒氣味之材料。

本研究也瞭解氣味是趕走蚊蟲最重要的方法，使用中低溫(70-80℃)的方式，可以有效釋放植物本身的味道，讓乾式法的氣味可以有療癒和防蚊功能，既安全又環保，而且外型也可以客製化。

圖 1.　乾式兩用擴香器
Fig. 1. Dry type of dual-purpose diffuser.

Research and development of forest - gardenly therapy products

Forest Chemistry Division Kun-Yuan Hong

Forest-gardenly therapy (FGT) that the healing mechanism of FGT comes from relaxation–endocrine- nerve-immunity. After relaxation, the endocrine balance is reached, which gradually affects the nerves and enhances the killer cell of immunity. Subsequently, a screening platform for various cell and biochemical activities was established, including the active ingredients of Linyuan Healing for whitening, nerve, skin, anti-mosquito, immunity and endocrine can be quickly analyzed.

Important results:Develop aerosol healing device-dry dual purpose diffuser

Smoke-burning incense powder and mosquito-repellent coils often cause health and environmental problems. Dry diffuser is modified from the ancient decoction. It is a method of slowly releasing the odor and aroma without making the environment very humid. In today's environmental protection, the awareness of air pollution has risen to protect the respiratory tract and avoid the occurrence of lung cancer. Reduce the exposure of PM2.5, and this device can make full use of all materials with healing odors.

This research also understands that smell is the most important method to get rid of mosquitoes. The use of medium and low temperature (70-80℃) can effectively release the taste of the plant itself, so that the smell of the dry method can have healing and anti-mosquito functions, which is safe It is environmentally friendly, and the appearance can also be customized.

林園療癒樹種葉部芬多精等揮發物質成分解析

陳盈如

一、中文摘要

為瞭解蓮華池療癒基地不同步道之芬多精組成及其季節性差異，本試驗利用現場採樣(*In situ* sampling)的方法搭配ATD-GC-MS (Auto-thermal desorption-gas chromatography-mass spectrometry)進行芬多精成分分析。結果顯示蓮華池療癒基地之芬多精組成以Limonene (13.12±10.5 – 63.79±9.4%)與Linalool (2.50±1.40 – 52.2±25.1%)相對含量較高，其餘包括Terpinen-4-ol (5.23±2.30 – 23.88±0.30%)、β-Myrcene (0.90±0.30 – 25.56±23.1%)等單萜類成分與倍半萜類化合物α-Cedrene (2.71±1.30 – 10.01±4.80%)。不同季節的空氣中芬多精之濃度依序為秋季(4053.7±1700.6 ng m^{-3}) > 春季(3105.9±1193.7 ng m^{-3}) >夏季(23342± 847.6 ng m^{-3}) >冬季(923.0±411.4 ng m^{-3})。

此外，根據空氣中正負離子比計算之單極係數指數，除春季(q = 1.05±0.04)之外，其餘季節(q = 0.75±0.07 - 0.85±0.02)皆屬於舒適優良等級；而在空氣清潔度方面，則以夏季與秋季(CI = 3.10±1.46、1.56±0.20)略優於冬季(0.87±0.01)與春季(0.76±0.06)。

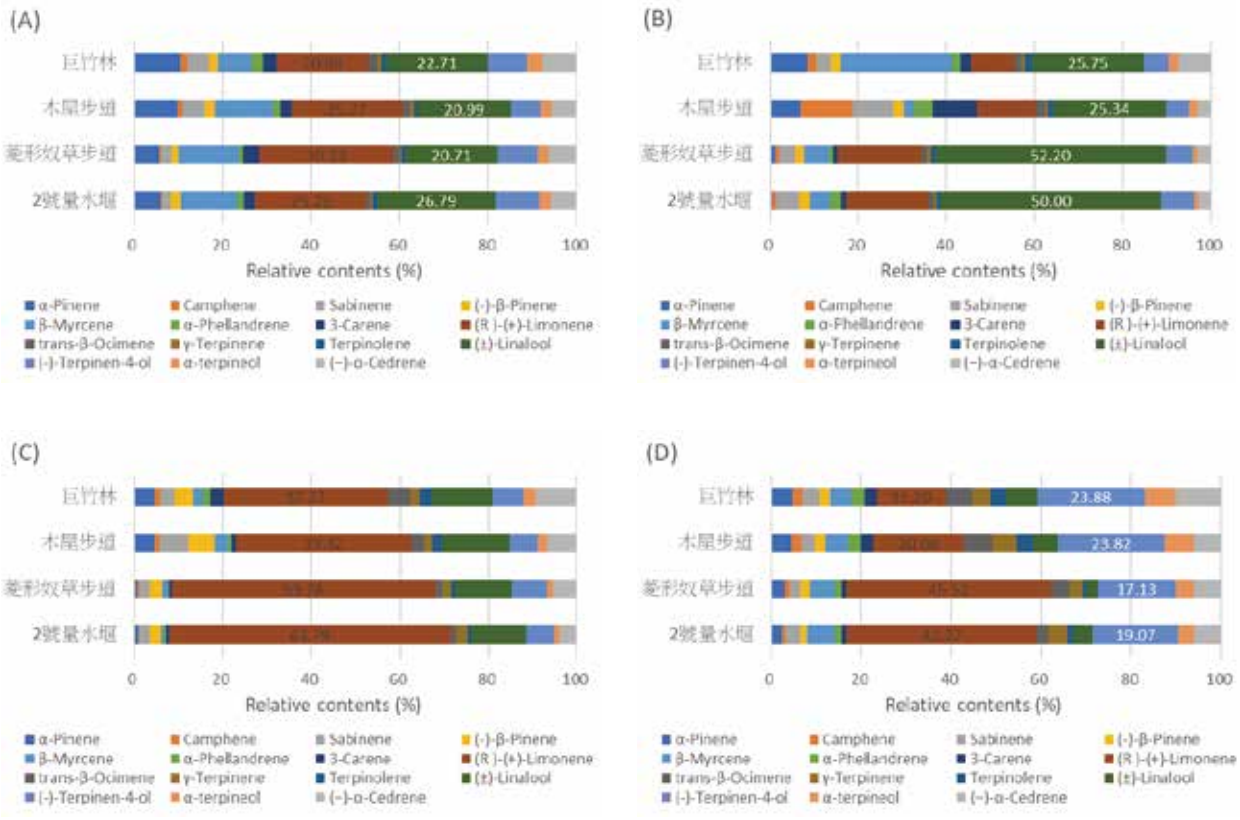


圖 1. 四條森林療癒步道不同季節之芬多精組成。(A)春季、(B)夏季、(C)秋季、(D)冬季)。

Fig. 1. The phytoncide composition of four forest trails in four forest trail at different seasons. (A) Spring, (B) Summer, (C) Fall, (D) Winter.

Analysis of Volatile Substances of Fendolin in the Leaves of Healing Tree in Forest Garden

Ying-Ju Chen

The seasonal variations of chemical composition of four forest trail in Lienhuachih Research Center were studied. BVOCs were analyzed by auto-thermal desorption and gas chromatography coupled to a mass spectrometer (GC/MS). The results showed that both limonene (13.12±10.5 – 63.79±9.4%) and linalool (2.50±1.40 – 52.2±25.1%) were the major components of BVOCs, followed by terpinen-4-ol (5.23±2.30 – 23.88±0.30%), β-Myrcene (0.90±0.30 – 25.56±23.1%), and a sesquiterpenoids α-cedrene (2.71±1.30 – 10.01±4.80%). Furthermore, pollution index is defined as the ratio of positive to negative air ion ratio. The concentration of BVOCs in different seasons were as followes: Fall (4053.7±1700.6 ng m^{-3}) > Spring (3105.9±1193.7 ng m^{-3}) > Summer (23342±847.6 ng m^{-3}) > Winter (923.0±411.4 ng m^{-3})。

As regard to the Unipolar coefficient, that made as the air quality index and showed the except for in Spring (q = 1.05±0.04), the Unipolar coefficient in other seasons were below 1.0 (q = 0.75±0.07 - 0.85±0.02), air quality is “good”. In addition, the evaluated results based on air ions hygienic evaluation suggest that the air quality in Summer and Fall seasons were reach the A-level, suggesting the excellent air quality; while the air quality in Winter and Spring seasons were reach the B-level (good air quality).

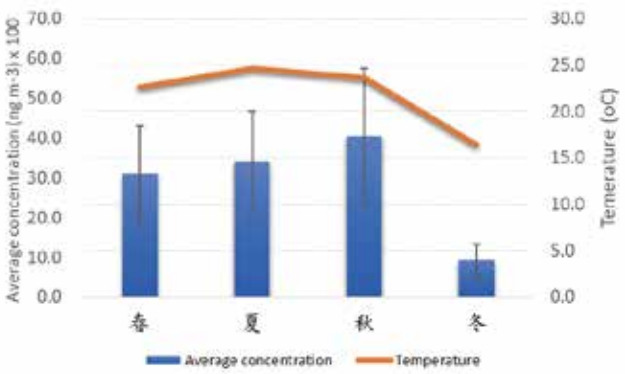


圖 2. 不同森林療癒步道四季芬多精濃度之變化。

Fig. 2. Seasonal variation of phytoncide concentration in different forest trails.

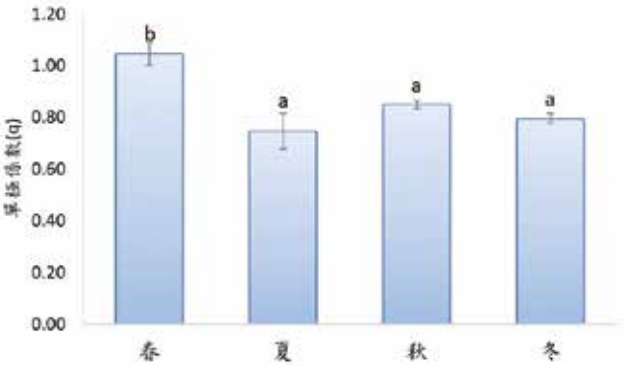


圖 3. 不同森林療癒步道四季之環境舒適度指標。

Fig. 3. Seasonal variation of Unipolar coefficient in different forest trails. (at 0.05 level by Scheffe’s test). (Mean±SE, n > 30).

運用植物資源創造氣味特色—以《香氣印記—看不見的植物園展》為例

葉若鋆

森林療癒中包括運用五感浸淫在大自然中，重要的是如何引領喚起當下的感官體驗。以台北植物園為整個展覽場域，四個氣味體驗點分布在不同場館。展覽的初衷是希望大家能夠有意識的專注當下開啟嗅覺行為，不堆疊太多植物或精油萃取的知識，並刻意弱化其他感官刺激，減少擺設和太多色彩的干擾，讓大家能夠靜心感受展場氣味所傳遞的訊息和氛圍，走出展示間後也能覺察到在植物園不同角落所迸放的氣味。

在台北植物園舉辦的植物氣味特展(109,12,25～110,2,9)，以台北植物園的香味植物地圖為主軸，並創造出不同場館的香氣，此次展覽除了展出12種植物氣味，並選取芳樟、白玉蘭、桂花、台灣扁柏等4種台灣原生植物精油，調配出依序代表春夏秋冬的4種調香，打造專屬台北植物園的嗅覺標識。展期共28天，總參觀人次共12,852，分析389份問卷，年齡以40-60歲居多，居住台北市、新北市為主，其他地區為11.8%，恰巧路過看展的居多(66%)，所以在策展時需考量非特定族群的需求。有精油使用習慣者對植物氣味的敏感度較高，對展覽的感受度和滿意度也較高。展覽後期因應新型冠狀病毒肺炎疫情，原來玻璃聞香罩的體驗方式也改為將聞香紙嗅聞香氣，這一張聞香紙上蓋有台北植物園的鋼印(視覺標識)，並有著台北植物園嗅覺標識(olfactory logo)的氣味，可讓遊客帶回去再三回味。

展示場內的氣味體驗。
The scent experience in the exhibition cabin.

Utilization of plant resource in generating odor characteristics: a case study of " Fragrance Imprint - the Invisible Taipei Botanical Garden"

Ruo-Yun Yeh

Forest therapy involves using all five senses to become immersed in nature. The important thing is how to lead the current sensory experience in forest therapy. Taking the Taipei Botanical Garden as the entire exhibition area, four scent experience points are distributed in different spots. In order to visitors consciously attention to smell, less knowledge of plant or essential oil extraction, weaken other sensory stimulation, reduce decoration and color in the exhibition. The visitors calmly feel the message and atmosphere conveyed by the flavor of the exhibition cabin, and perceive the odor around the botanical garden after walking out of the exhibition cabin.

An odor exhibition was held at the Taipei Botanical Garden from December 25th, 2019 to February 9th, 2020 to highlight the smelling-featured plant species in the garden. There were 12 types of essential oil and 4 types of essential oil blend in the exhibition. Four flavors from native species, namely camphor (*Cinnamomum camphora*), white champaca (Michelia x alba), osmanthus (*Osmanthus fragrans*) and Taiwan cypress (*Chamaecyparis obtusa* var. formosana), were selected to feature the spring, summer, fall and winter, respectively. The season blends were used as "olfactory logo " of Taipei Botanical Garden. The total visitor number to the exhibition was 12,852 by 28 days. The stats based on 389 questionnaire samples shows the majority of visitors was aged 40-60 years old, primarily from Taipei city and New Taipei City, whereas only 11.8% of the visitors was from other areas. Most visitors stopped by the exhibition (66%), so we should consider non-specific groups in curation. The visitors who had experienced in essential oils before were more sensitive to different types of the exhibited smells and show higher satisfaction of the exhibition. Responding to COVID-19 pandemic in the late stage of the exhibition, the original experience of the flavor smelling with glasses was changed to smelling with paper. The piece of smelling paper is covered with the steel seal visual logo and olfactory logo of the Taipei Botanical Garden. The paper with evocative flavor was taken away by visitors and smell again.

傳統林產品創新加值研究——商用木材資料庫及數位化木材標本之建立

李金梅、何振隆、林振榮、黃國雄

全球對於生活及生態環境的重視，讓木材的需求遭遇生活與生態的衝突，樹木在生長過程累積木質材料，若在永續條件下使用，將是友善環境的生態材料，故提升森林或木材相關教育，並加強永續使用木材的認知是極為重要。

喜好使用木材的民眾或賣賣木材的商家，對於木材的了解是由市場的訊息傳遞而來，並無準則可依循，因而常有糾紛；而木材標本館館藏國內外木材標本達2000餘種，約有28000份木材標本，藉由此計畫逐步建立數位化檔案供多元使用如鑑定、教學和環境教育等。數位檔案置於商用木材查詢網，藉此讓國人深入了解國內森林資源之木材。

本工作項目於106年整合木材標本數位化及商用木材基本性質資料建立兩項目，木材標本數位化計完成國產木材24科69屬162種、進口木材10科59屬101種、商用木材15科27屬31種。木材標本數位化部分，乃將木材三切面外觀形態之色澤和紋理及組織解剖特性藉由拍照將特徵數位化，並針對近年市場常用之商用木材進行組織解剖及物理強度與化學性質之研究，以建立木材基本資料。

圖 1. 殼斗科木材數位化。
Fig. 1. Digitization of Fagaceae wood.

Establishing the database of the commercial wood and digitizational wood specimens.

Chin-Mei Lee, Chen-Lung Ho, Cheng-Jung Lin & Gwo-Shyong Hwang

Increasing the importance of life and ecological environment, demands for woods lead to encountering conflicts between life and ecology, entirely. Trees accumulate wood materials during their growth. If woods used under sustainable conditions, they would be the ecological materials those are friendly to the environment. Strengthening education of forest or woods and the awareness of sustainable utilizations of woods are extremely important.

People or merchants who like using woods, their understanding of wood is transmitted by market information, and there have no guidelines to follow, so there are often disputes; and the Wood Herbarium has more than 2,000 domestic and foreign wood specimens. There are about 28,000 wood specimens. Through this project, digitized files will be gradually established for diversified use such as identification, teaching and environmental education. The digital files are placed on the commercial timber inquiry network, so as to let the most people understand the timber of the domestic forest resources.

This project integrated the digitization of wood specimens and the establishment of basic property data of commercial wood in 106. The digitization of wood specimens completed the completion of domestic wood 24 families, 69 genera and 162 species, imported wood 10 families, 59 genera and 101 species, and commercial wood 15 families and 27 genera and 31 species; the digitization of wood specimens is the digitization of the color, texture and tissue anatomical characteristics of the appearance of the three-section surface of the wood by taking pictures. Besides, commercial wood is used for the tissue anatomy and physical strength and chemical properties of the wood commonly used in the market in recent years to research and to establish basic information about wood.

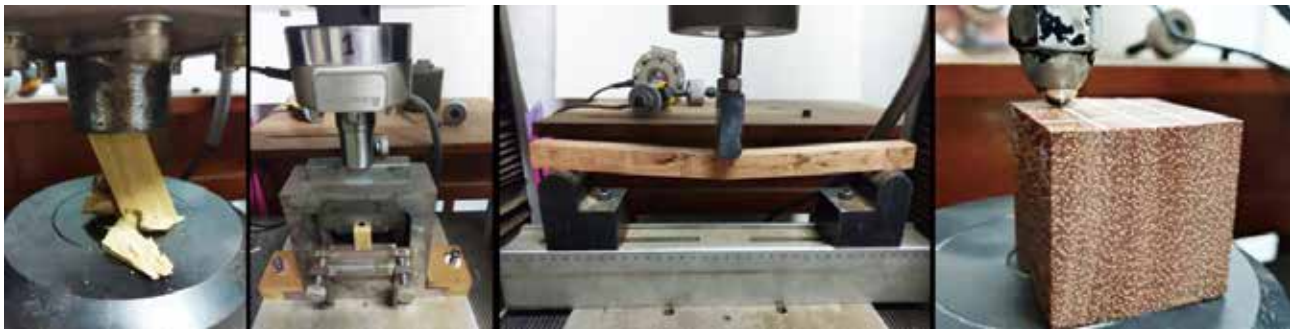


圖 2. 商用木材物理強度試驗。
Fig. 2. Commercial timber physical test.

瓊崖海棠種仁有效成分與機能性產品研發

林柏亨、顧文君、林振榮

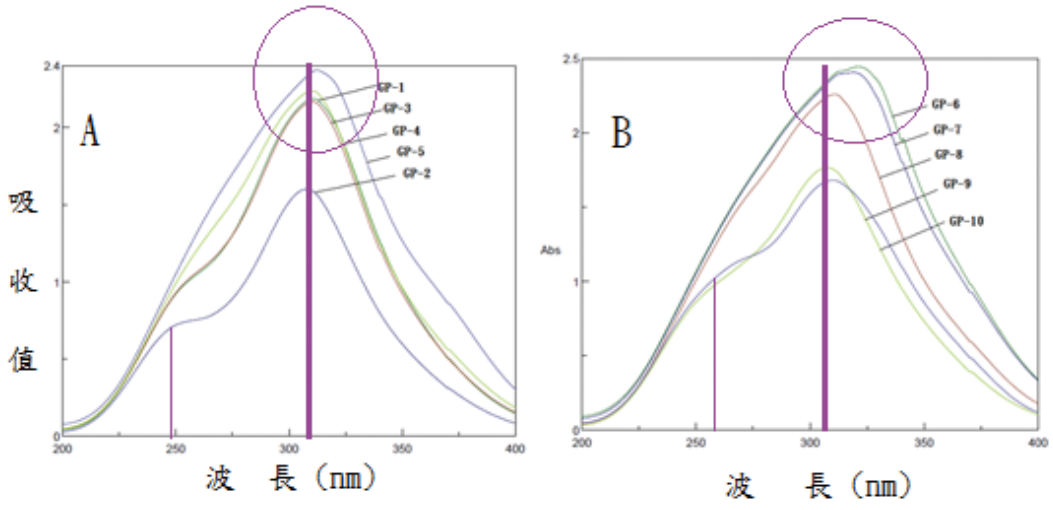
本計畫以海濱植物瓊崖海棠(*Calophyllum inophyllum* L.)種仁為材料，該樹種主要分佈於亞洲、非洲及其他太平洋島嶼國家，其種仁含油量豐富，高達48%。利用管柱層析方式將其細分為10個不同分流層，其中偏向極性分流層紫外光吸收圖譜更偏向400 nm方向，也就是比起他分流層更具有屏蔽UVA波段之潛力併綜合紅外光圖譜(IR)特徵吸收成果，因該是所含化合物含有苯環官能基所貢獻。防曬係數SPF (Sun protection factor)和PA防曬等級(Protection Grade of UV-A)表示為國際上通用作為評估紫外線遮蔽劑對於避免皮膚受紫外光照射受損之人體試驗指標，研究發現瓊崖海棠種仁抽出物具有屏蔽紫外線區段光線之能力。總酚與類黃酮含量經分析後顯示瓊崖海棠種仁抽出物總酚含量較市售橄欖油高，類黃酮含量則較市售橄欖油低。市售多種常用化學美妝防曬品所含成分已被試驗研究證實會影響海洋生態，若能自植物種仁萃取具紫外光屏蔽之成分，有望部分取代或替代化學防曬劑之產品，不僅將能避免影響海洋生態與造成浩劫外，亦可增加瓊崖海棠高附加價值與機能性產品應用層面。

瓊崖海棠種仁與瓊崖海棠種仁抽出物外觀。
Appearance of seed kernels and seed extracts of *Calophyllum inophyllum*.

Study and development of active ingredients and functional products of *Calophyllum inophyllum* seeds

Po-Heng Lin, Wen-Jun Ku, Cheng-Jung Lin

This project is based on the seeds of the seaside plant *Calophyllum inophyllum* L., a species found mainly in Asia, Africa and other Pacific Island countries, whose seeds are rich in oil content, up to 48%. It is divided into 10 different manifold layers by column chromatography. The UV absorption spectrum of the polarized manifold layer is more in the direction of 400 nm, which means that it has more potential to shield the UVA band than other manifold layers, and the absorption results of the IR characteristics are combined because the compound contains benzene ring functional groups. The SPF (Sun protection factor) and PA (Protection Grade of UV-A) are commonly used internationally as indicators for evaluating the effectiveness of UV shielding agents to prevent skin damage from UV radiation. It was found that the extracts of seeds had the ability to shield light in the UV region. The total phenol and flavonoid content of the extracts from seeds were analyzed and found to be higher than that of olive oil, while the flavonoid content was lower than that of commercially available olive oil. Many commercially chemical sunscreens contain ingredients that have been tested and proven to affect the marine ecology. If UV shielding ingredients can be extracted from plant seeds, it is expected to partially replace or substitute for chemical sunscreens, which will not only avoid affecting the marine ecology, but also increase the application of high value-added and functional products from *Calophyllum inophyllum*.



分流層GP01～GP10之紫外線光譜圖A:分流層GP01～GP05 B:分流層GP06～GP10。
UV spectra of from GP1 to GP10, A: GP01~GP5 B: GP6~GP10.

森林蜜揮發成分分析

Analysis of Volatile Components of Forest Honey

許富蘭
Fu-Lan Hsu

台灣蜂蜜進5年年產量約3000~9000公噸，由於國內產量不足以內需，每年仍有大量由國外進口，在氣候、農藥等問題下，台灣蜂蜜產量更是銳減。蜂蜜長期存在有混摻等問題，鑑定蜂蜜品質及來源的需求大增。然而，傳統分析方法有其限制，需有更靈敏、快速、易理解的分析方法。

本研究首先至產地收集可溯源之不同季節蜂蜜進行試驗，共獲得該區不同季節之主要開花木本植物如樟櫟群叢、水筆仔、紅淡比、四樹蜜(酸藤、樹杞、水金京、烏桕)、米碎柃木、柚子、鴨掌柴(江某)等蜂蜜。

蜂蜜香氣成分以固相微萃取(Solid-Phase Microextraction, SPME)獲得，相關分析技術經不同條件(溫度、時間、總量) 測試及優化後，可獲得較佳之吸附效果，此外亦探討降低含水率過成可能涉及的熱處理對蜂蜜揮發成分之影響。

相關成果除辦理品蜜及蜜產品教作等活動，亦發表「大溪不同蜂箱未濃縮森林蜜揮發成分比較」及「固相微萃取(SPME)分析蜂蜜揮發成分之吸附條件最適化」兩篇研討會報告。

The annual honey production of Taiwan is about 3,000 to 9,000 tons in five years. A large amount of honey is still imported from abroad every year since the domestic production is not enough for domestic demand. Due to the climate and pesticide issues, Taiwan's honey production has dropped sharply. The demand for identifying the quality and source of honey has greatly increased due to the long-standing problems such as adulteration. However, there are some limitations for the related analysis methods, and more fast and easy-to-understand analysis methods are needed.

In this study, traceable honey from trees blossomed in different seasons, including Cinnamomum, Quercus, Kandelia obovate, Cleyera obovate, Ecdysanthera rosea, Ardisia sieboldii, Wendlandia formosana, Sapium sebiferum Eurya chinensis, Citrus maxima, Schefflera octophylla, et al. were collected.

Volatile compounds of honey are obtained by solid phase microextraction (solid phase microextraction, SPME) and the optimized analytical methods were established. The effect of heat treatment on the volatile components of honey was also dicussed.

Relevant results are presented in events such as “Forest honey tasting”, “Forest honey products workshop”, etc. Two seminar reports, “Comparison of the volatile components of the unconcentrated forest honey from different beehive“ and “Study on optimization of solid-phase microextraction and gas chromatography-mass spectrometry analysis for the volatile components of forest honey” were also published.

森林蜜品評活動 。
Forest honey tasting.

森林蜜產品教作 。
Forest honey products workshop.

包裝紙及染料林產品應用之初探

Preliminary Study on the Application of Packaging Paper and Natural Dye Products

何振隆、徐健國、徐光平
Chen-Lung Ho, Jiann-Gwo Shyu, Kuang-Ping Hsu

於包裝紙及染料林產品應用之初探方面，首先為包裝用紙箱類課題，為蒐集包裝用紙箱類之台灣整體產銷狀況、文獻、訪談專家及廠家等，並分析出未來包裝紙箱三大趨勢，包括：綠色環保化原料、緩衝材減塑及包裝功能化加強等。於改善方面，即以所回收廢紙為原料，進行再生纖維改質，使成高強度及輕量化之包裝材料；利用對人體無毒性植物抽出成分應用於抑菌及保鮮包裝紙研發，防止食品遭微生物侵染，保護消費者身體健康。於染料林產品應用課題，其提取方法包括直接提取法、有機溶劑提取法、超音波提取法及超臨界流體萃取法等四種。染色方法包括直接染色法、媒染法、還原染色法等。依染料應用的差異可將植物染料分為直接型、媒染型、還原型和陽離子型植物染料。目前植物染色應用的領域主要多用於織品及設計上，普遍遇到的問題是顏色光堅牢度不佳，所以需要選用較不易褪色的染料進行染色加工，但是目前尚未有做文物修復及防褪色的研究。再者，於染料工業發展，應該將產品進行國際化行銷，而不能僅靠本地市場。

In the preliminary study on the application of packaging paper and natural dye products, we collected the overall production and marketing status of packaging paper products in Taiwan, literatures, interviews with experts and manufacturers, and analyzed three major trends in the future. The three major trends in the future are green and environmentally friendly raw materials, plastic buffer material reduction, and enhancement of packaging functionality. Recycled waste paper is used as raw material, and modification of regenerated fiber to produce a high-strength and lightweight packaging material. Use non-toxic plant extracts to develop antibacterial and fresh-keeping packaging paper to prevent food from being infected by microorganisms and protect consumers' health. There are four main methods for extracting natural dyes: direct extraction, organic solvent extraction, ultrasonic extraction, and supercritical fluid extraction. Dyeing methods using natural dyes include direct dyeing, mordant dyeing, and vat dyeing. According to the difference in the use of natural dyes, it can be divided into direct, mordant, vat, and cationic natural dyes. At present, natural dyes are mostly used in fabrics and designs. The disadvantage of natural dyes in use is poor color fastness to light. We need to use dyes that are less prone to fading for dyeing. There is no research on the color restoration and anti-fading of cultural relics. The development of the dye industry should carry out international marketing, not just local marketing.

不同植物染的絹 。
Different natural dyes silk.

產業知識平台開發與應用

塗三賢

建立從國產材的原料生產到加工製造，規劃設計到產品製造，乃至市場銷售端到服務平台建立的產業鏈，產銷的可行性評估及推廣模式的資訊，擴充森林副產物知識資料庫，提供正確且廣泛的知識供業者及民眾使用，是重要的議題。本計畫延續前一年度完成的林產業知識平臺架構規劃，持續蒐集與篩選相關木材利用的資訊，結合本所已建立的林產技術服務平台，強化林產業知識平台資訊內容，讓國人更貼近國產木材的使用。已完成蒐集林產技術服務平台資訊相關知識內容約100筆，編修100筆林產技術服務平台資訊內容並上架。完成修正或補充商用木材查詢資料庫中樹種資料的加工性質、材面顏色及加工用途等資料200多筆。

林產業知識平臺提供商用木材的查詢。
The Forest industrial knowledge platform provides inquiry of commercial timbers.

Development and Application of Industrial Knowledge Platform

San-Hsien Tu

Establishing an industrial chain from raw material to processing and manufacturing of domestic materials, planning and designing of product manufacturing, and establishing from market to end-service platform, and providing correct and a wide range of knowledge for the industry and the public are all important issues for expanding domestic wood market. This project collects and screens information related to wood, combined with the established forest industrial knowledge platform of TFRI, strengthens the information content of the forest industry knowledge platform, and allows people to be closer to the use of domestic wood. The project has collected and edited more than 100 of information related to forest products technology on service platform. Completed correction or supplementation of more than 200 data on the material properties, surface color and others data of some tree species in the commercial timber query database.

機器學習應用於國產木材辨識技術

李金梅

木材種類在辨識鑑定時，常會以木材橫切面細胞組織的形態特徵作為判斷依據，但具木材辨識專長之人員日益減少，而現場人員則仰賴過去經驗作為判斷，如氣味和色澤等較不客觀之特徵。為強化漂流木處理上貴重木材之標示，與林政案件上木材辨識，本研究以木材橫切面組織之特徵進行機器學習之辨識。

首先以貴重木材中之臺灣櫸(*Zelkova serrata*).為重點辨識標的，再輔以木材組織形態相似之半環孔及環孔木材進行訓練，半環孔至環孔木材分別有楝樹(*Melia azedarach*)、黃連木(*Pistacia chinensis*)、柚木(*Tectona grandis*)及榔榆(*Ulmus parvifolia*)等4種木材，合計進行5種半環孔至環孔木材，及ResNet-50、VGG-16、Inception-ResNet-v2、MobileNetV2等4種深度模型之機器學習訓練。

4種深度模型在訓練資料及驗證資料集皆達99%以上的準確率如圖所示，測試資料集利用智慧型行動裝置結合夾式放大鏡，對五種國產木材之橫切面各取20張影像，測試混肴矩陣結果顯示，在四種模型中，Inception-ResNet-v2的整體準確率(91%)為最高，其次為MobileNetV2的準確率(90%)。從混肴矩陣中可以看出Inception-ResNet-v2與MobilenetV2對於楝樹、黃連木、柚木的辨識率較高，對於榔榆、櫸木則會有互相混淆的情形發生。

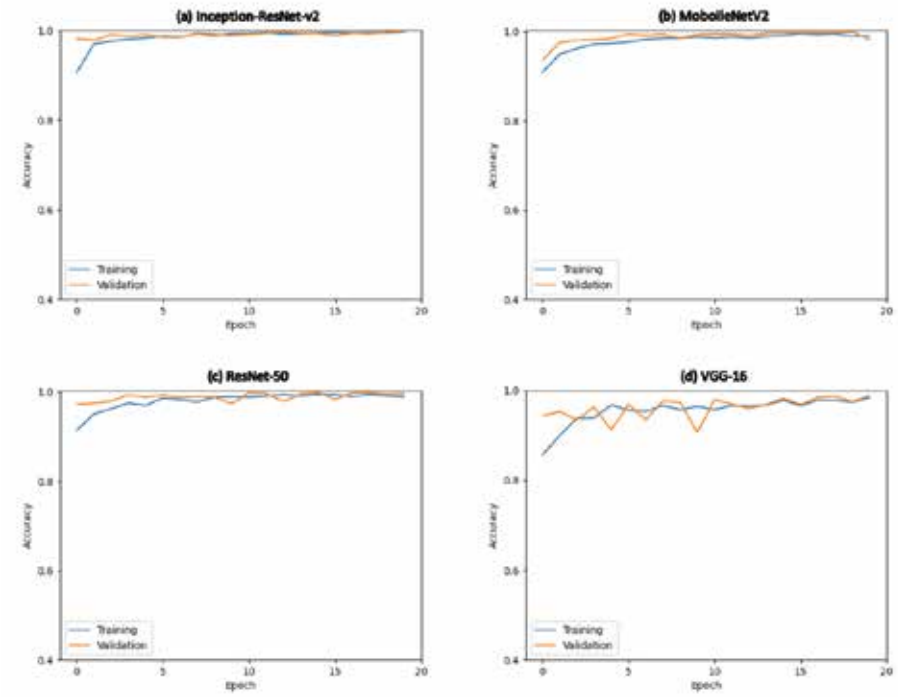


圖 1. 訓練集與驗證集準確率，(a) Inception-ResNet-v2，(b) MobileNetV2，(c) ResNet-50，(d) VGG-16。
Fig. 1. Training and verification accuracy, (a) Inception-ResNet-v2, (b) MobileNetV2, (c) ResNet-50, (d) VGG-16.

Machine learning applied to domestic wood identification technology

Chin-Mei Lee

To identify the species of woods，we usually determine by their features of wood cross section cell tissue in the lab, but the official staffs usually determine by their experiences (e.g. fragrance or color of woods) on site. Decreasing number of people who specialize in identifying, traditional determination will lead to numerously incorrect problems, however. For strengthening identification of driftwood on site, we study in Identify the characteristics of wood cross-section structure by machine learning.

First of all, we pick Zelkova (*Zelkova serrata*) for the main subject ,then choose four species bead tree (*Melia azedarach*)、pistache (*Pistacia chinensis*)、teak (*Tectona grandis*)、elm (*Ulmus parvifolia*) to train machines on similar features of wood ring-porous and four types of Depth model (ResNet-50、VGG-16、Inception-ResNet-v2、MobileNetV2).

In training data and verification data of four kinds of Depth model, they all reach 99% accuracy(fig).According to the results of Test Confusion Matrix, Inception-ResNet-v2 reaches the highest accuracy(91%), MobileNetV2 reaches 90% ,then. We use Smart mobile device combined with clip-on magnifier to get the data set of Cross section of five types of wood from Confusion Matrix, the recognition rate of Inception-ResNet-v2 and MobilenetV2 for bead tree、pistache and teak are higher, but those occur Confuse each other for elm and Zelkova.

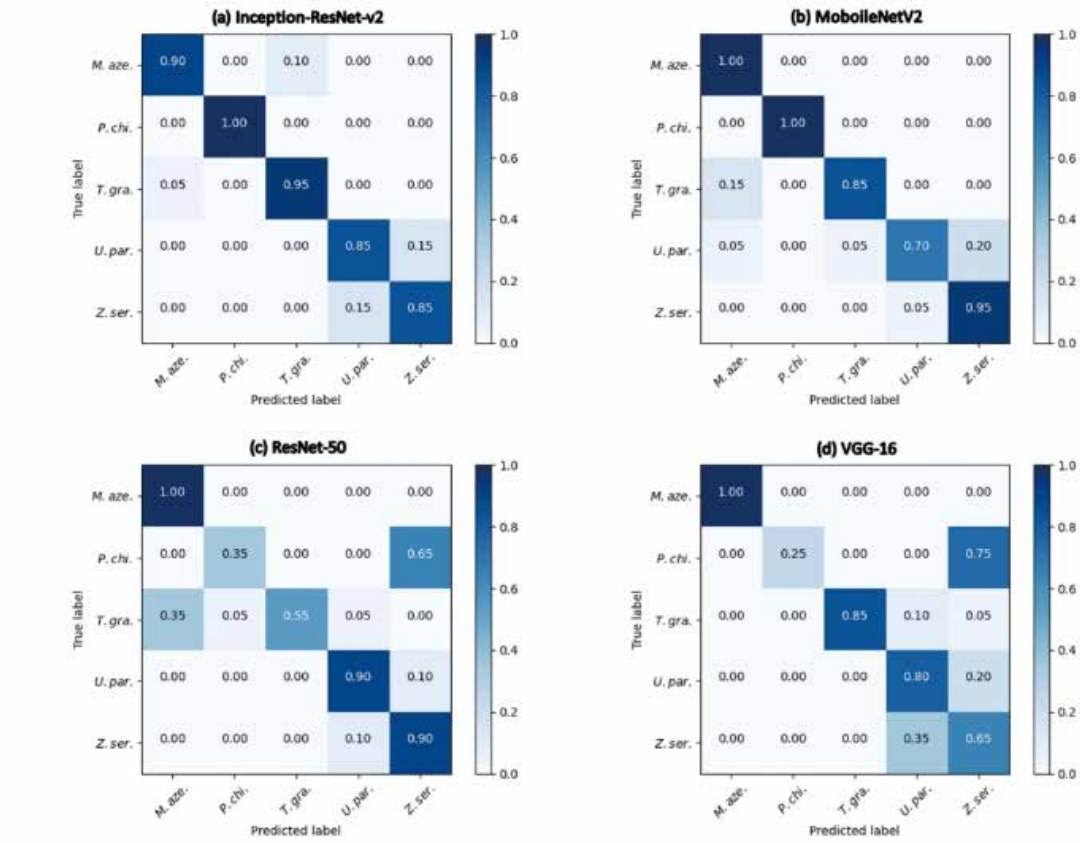


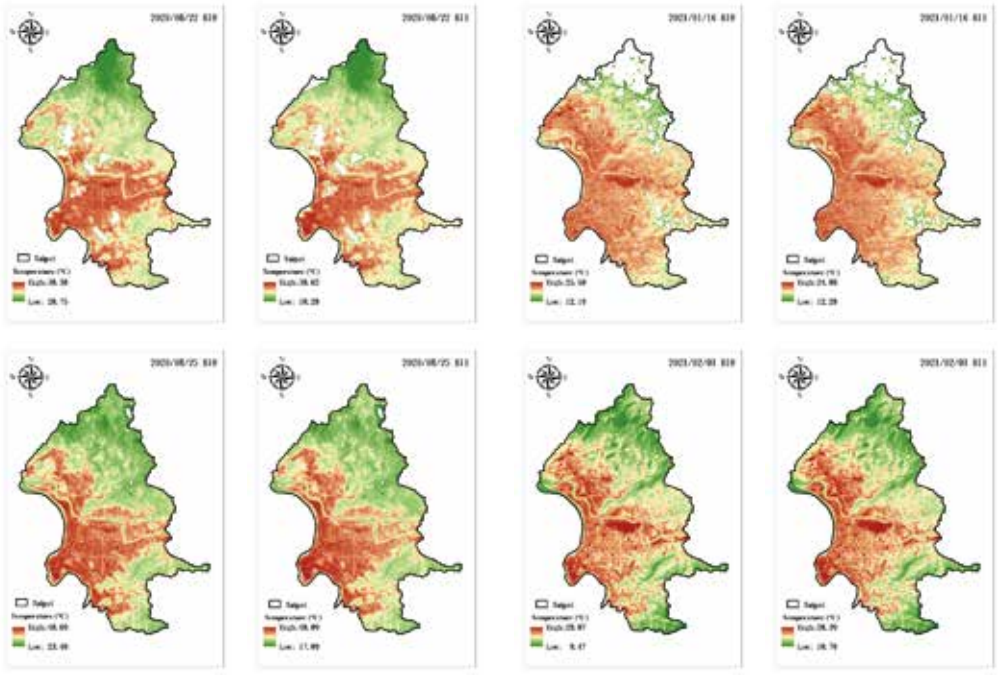
圖 2. 各模型之混淆矩陣，(a) Inception-ResNet-v2，(b) MobileNetV2，(c) ResNet-50，(d) VGG-16。
Fig. 2. Confusion matrix, (a) Inception-ResNet-v2, (b) MobileNetV2, (c) ResNet-50, (d) VGG-16.

韌性都市林綠化系統之環境改善功能監測與效益評估

陸象豫

本計畫目標之一為探討都市林對改變局部區域的氣溫及減緩都市熱島效應(urban heat island)的功效，爰此選定台北植物園設置溫濕度監測器，探討植物樹冠層對改變微氣候(氣溫及相對溼度)的作用，另以整個台北市為試區，藉Landsat-8 熱紅外線(Thermal Infrared)探討植生分布對都市氣溫的影響。植物園試區每小時監測一筆資料，共累積16個月的紀錄；熱紅外線資料則選定2020年6月22日與8月25日及2021年1月16日與2月1日上午10：30分所拍攝的影像微分析對象。植物園樹冠層上下方及林試所行政大樓頂層一年餘的紀錄顯示，此三處監測點年均溫分別為：23.79、23.37、及24.33℃，樹冠層上下方的時均溫在五月07：00 至08：00、六月01：00至12：00 及22：00至24：00、七月01：00至02：00及07：00至14:00、八月01：00至13:00、及九月08：00至09：00 等時段有顯著的差異 (達95%顯著水準)；頂樓及樹冠層上方的時均溫在三月07：00至10：00、四月08：00至09：00、五月05：00至10：00、六月06：00至12：00、七月06：00至14：00及八月07：00至13：00 等時段有顯著的差異。此等差異的時段均屬較高溫的時段，此期間樹冠上方的氣溫均在28.0℃以上；顯示在炎熱的時段，植物的遮蔽確實能顯著地降低其下方庇蔭處的氣溫，然而在氣溫較低的夜間及秋冬等季節，氣溫主要決定於氣流(air current) 的溫度及其強度，植物覆蓋對改變區域氣溫的作用則多屬不顯著。

本計畫將夏季及冬季各兩次熱紅外線波段10(波長10.60 to 11.19 μm) 及波段11 (波長11.50 to 12.51 μm) 的影像轉換為熱輻射強度 (thermal radiation intensity) ，以此強度推求地表的亮度溫度 (brightness temperature，TB)，再將亮度溫度與氣溫觀測站實際觀測的溫度尋求關係式，並以此推求地表溫度。所得結果顯示，亮度溫度與實測溫度(T)間的回歸關係式為：T = 1.328TB-4.460 (相關係數 R2 =0.91)，以此關係式所推估台北市區四個拍攝時間的溫度如下圖所示。顯示無論夏季與冬季，台北市區綠地、水域的溫度明顯低於商業及住宅等建地密度高的區域，其間溫度的差異可達5℃，顯示都市林對減緩熱島效應有顯著的效果。



台北市溫度分布圖。
Distribution of surface temperature for the Taipei meteorological area.

Evaluation on the ability of environmental improvement and benefit for the urban forest system

Shiang-Yue Lu

One of the goals of this project is to explore the effects of urban forests on regulating local temperature and mitigating the urban heat island effect. Three set of temperature and relative humidity monitoring devices were installed on top and below urban forest canopy at the Taipei botanical garden (TBG) and top of the administrative building to monitor those meteorological factors. In addition of temperature and relative humidity records at TBG, this study also used the Landsat-8 thematic mapper (Landsat-8 TM) images from the Center of the United States Geological Survey for large area surface temperature estimation and evaluating vegetation covers effects on urban air temperature. There are about 18 months temperature and relative humidity hourly records accumulated at present and four thematic images taken at 10:30am of June 22, 2020, August 25, 2020, January 16, 2021 and February 1, 2021 were used for analysis. More than one year records of those three temperature monitoring spots indicated that the yearly average temperature of above canopy, below canopy and top building were 23.79, 23.37, and 24.33°C, respectively. Hourly average temperatures between above and below canopy have significant difference at May 07:00 to 08:00, June 01:00 to 12:00 and 22:00 to 24:00, July 01:00 to 02:00 and 07:00 to 14:00, August 01:00 to 13:00 and September 08:00 to 09:00 (up to 95% significant level). Hourly average temperatures between top building and above canopy at March 07:00 to 10:00, April 08:00 to 09:00, May 05:0010:00, June 06:00 to 12:00, July 06:00 to 14:00 and August 07:00 to 13:00 showed significant difference. These different temperature periods are all time periods of higher temperature and during which the air temperature above the canopy is above 28.0°C. This phenomenon indicated that the canopy of plants can significantly reduce the temperature in the shelters below it and the air temperature is mainly determined by the intensity and temperature of air current during the colder period which generally is autumn and winter seasons or during night of summer. The effects of vegetation cover in reducing air temperature are insignificance during colder period.

Four thermal infrared band 10 images (B10, wave length is 10.60 to 11.19 μm) and bang 11 (B11, wave length is 11.50 to 12.51 μm) images (taken both twice in summer and winter) were converted into thermal radiation intensity and the brightness temperature (TB) of the earth's surface is derived from this intensity. Then the relationship between the BT and the observed temperatures was established for estimation air temperatures above ground surface. The established linear relationship between TB and observed temperature (T) is T = 1.328TB-4.460 (Correlation coefficient R2 = 0.91). The distribution of estimated temperature through this equation for those four shot times are shown in the figure below. It shows that the temperature of vegetation and water area in Taipei urban area is significantly lower than that of commercial and residential areas with In both summer and winter and the temperature difference can reach 5°C, which indicates that urban forests have a significant effect on mitigating the heat island effect.

都市複層林生態網絡強化與管理技術之研究

葛兆年、張東柱、陸聲山、陳一銘、傅淑瑋、黃愷茹

本計畫以建構韌性都市林為主要目標，提升都市林所帶來的生態與社會效益。韌性都市林營造之示範區位於新北市中和四號公園，樹種的選擇原則是原生種、適地適種，以及多樣性，同時強調整體森林的營造，比較能形成有韌性的都市林。2020年已建造韌性喬木區及灌叢區，為當地增加原生植物共14種喬木及15種灌木，具有淨化空污、耐旱、抗風以及提供蝴蝶鳥類食物來源等多項功能。另一方面以既有都市複層林的台北植物園為基準，評估複層林建構可能的生態效益。所得結果包括：台北植物園複層林的外來種鳥類種數及數量較少，但原生種類數及數量與中和公園的單層林沒有明顯差異。台北植物園有螫蜂類(授粉蜂類、狩獵蜂類)有57種，隧蜂科為優勢類，中和公園有48種，蜜蜂科為優勢類。地棲性節肢動物以中和公園的彈尾目及半翅目數量顯著較高，可能與環境開闊以及植栽較單純有關。台北植物園發現30種木棲性大型真菌，但其中有害木層孔菌造成園區嚴重的樹木褐根病。在中和公園僅發現兩種大型真菌，應與公園歷史不長及土壤表面少落葉有關，有害木層孔菌(*Phellinus noxius*)造成一棵大榕樹褐根病及該樹倒伏，另一種為土棲腐生菇類(*Agaricus bresadolianus*)。為了推廣韌性都市林理念，本計畫已發佈16部「就是要韌性！」系列影片；成立「韌性都市綠資源」Facebook粉絲專頁，完成1座韌性都市林解說牌、3座生態灌叢解說牌及88個植物解說牌；完成1式「合作備忘錄」、1場「灌叢生態化活動」及17場「韌性都市林志工隊培訓」課程。

圖 1. 韌性都市林示範區位於新北市中和區中和四號公園。
Fig. 1. The Resilient Urban Forest Demonstration Site has been located in Zhonghe No. 4 Park, Zhonghe District, New Taipei City.

圖 2. 本計畫與多個政府機關及民間團體在韌性都市林示範區合作營造複層林。
Fig. 2. This project cooperates with a number of GOs and NGOs to create multi-layered forests in the resilient urban forest demonstration site.

Research on Strengthening Urban Multi-layered Forest Ecological Network and Development of Management Technology

Chao-Nien Koh, Tun-Tschu Chang, Sheng-Shan Lu, Yi-Ming Chen, Shu-wei Fu, Kai-ju Huang

The main goal of this project is to form resilient urban forests to enhance the ecological and social benefits brought by urban forests. The demonstration area for the establishment of resilient urban forests is located in Zhonghe No. 4 Park in New Taipei City. The selection principles of tree species are native species, suitable planting for the site, and diversity. At the same time, it emphasizes the whole forest establishment, which can form a resilient urban forest. In 2020, resilient tree and shrub areas have been formed, adding 14 tree species and 15 shrub species, which have multiple functions such as purifying air pollution, drought tolerance, wind resistance, and providing a source of food for butterflies and birds. On the other hand, the Taipei Botanical Garden, which has an existing urban multi-story forest, is used as a benchmark to evaluate the possible ecological benefits of the multi-story forest construction. The results obtained include: The species richness and abundance of exotic birds in the multi-layer forest of Taipei Botanical Garden is relatively small, but the native species richness and abundance are not significantly different from the single-layer forest in Zhonghe Park. There are 57 species of aculeates (bees and wasps) in Taipei Botanical Garden, of which Halictidae were the most dominant group. Forty eight species of aculeates were found in Zhonghe Park, and Apidae as the dominant group. The number of terrestrial arthropods in Collembola and Hemiptera is significantly higher in Zhonghe Park, which may be related to the open environment and simple planting. Thirty species of wood-inhabiting macrofungi were found in the Taipei Botanical Garden, but among them, the wood-decay fungus (i.e., *Phellinus noxius*) caused the serious brown root disease in the park. Only two species of macrofungi were found in Zhonghe Park, which should be related to the short history of the park and the lack of deciduous leaves on the soil surface. *Phellinus noxius* caused brown root disease of a big banyan tree and the tree fell down. The other was soil-inhabiting fungus (*Agaricus bresadolianus*). In order to promote the concept of resilient urban forests, this project has released 16 series of videos on “It is to be resilient!”; set up a “Resilient City Green Resources” Facebook fan page; completed 1 interpretation panel on resilient urban forests and 3 interpretation panels on ecological shrubs and 88 plant signs; completed 1 “Memorandum of Understanding”, 1 “Creating Diversified Shrub Plant Activity” and 17 “Resilient Urban Forest Volunteer Team Training” courses.

圖 3. 研究人員指導志工營造有多種原生植物及多元生態功能的灌叢。

Fig. 3. Researchers of this project guided volunteers to create shrubs with a variety of native plants and multiple ecological functions.

都市林樹木風險智慧管理研究

吳孟玲、徐孟豪、劉則言、莊鈴木

2050未來城鄉發展有四項目標：幸福~友善城市、永續~韌性城市、智慧~智 慧城市與再生~綠色城市。為達成幸福、永續、智慧與再生，都市林綠色基礎建設扮演重要角色。健康都市林才能發揮其韌性與生態服務價值，健康都市林不論從前期規劃、種植、維護管理或災害調適，急需要一個好的維護管理系統，建立良好的都市林維護管理系統，是建構都市林永續性與韌性之重要工作。本計畫工作為建立都市林樹木健康評估平台，透過調查與分析可影響樹木健康之生物、非生物因子或其他影響樹木健康的危險因子，將以上資料進行權重分析，並藉由科學化的風險評估方法，決定樹木塌壞的可能性和後果分級，建立都市林樹木風險評估SOP，以預估樹木公安事件發生之風險高低，透過科學數據與資訊軟體結合，發展出都市林樹木風險評估智慧管理平台，可提供國內產、官、學界樹木維管使用，資料庫建立及未來大數字分析，期能有效強化臺灣都市林健康管理及韌性都市林的發展，並達到都市林的綠化與生態效益。109年本計畫主要完成工作說明如下： 1、完成都市林樹木生物與非生物因子調查、因子分析與評估。2、建立都市林健康評估表單與權重分析。3、建立都市林樹木健康評估分級標準。4、建置林木健康管理資訊平台，健康度分析包括：棲地環境、樹木狀況、樹冠評估、枝幹評估、樹根評估、病蟲害評估、維管護紀錄、照片等建立樹木健康分級。同時亦建立 100 筆老樹與 1000 筆樹木資料庫數據。5、辦理都市林相關座談會及講習課程共 4 場。

關鍵詞： 都市林、樹木健康評估、林木健康管理資訊平台

圖 1. 林木健康管理風險平台。
Fig. 1. Forest Health Management Information Platform.

Research on smart risk management for urban forest

Meng-Ling Wu, Meng-Hao Hsu, Tse-Yen Liu, Lin-Mu Jaung

There are four objectives for urban and rural development in 2050: happiness ~ friendly cities, sustainable ~ resilient cities, wisdom ~ smart cities and regeneration ~ green cities. In order to achieve these objectives, the infrastructure of urban forests plays an important role. Healthy urban forests can only exert their resilience and ecological service value. Regardless of early planning, planting, maintenance and management or disaster adjustment, healthy urban forests need a good maintenance and management system urgently. This project established a Forest Health Management Information Platform which can investigate and analysis the biological, non-biological or other risk factors that affect tree health. The data will be weighted and analyzed by scientific risk assessment methods to determine the probability of tree collapse. The platform was established for an urban forest risk assessment to estimate the level of risk of tree public security incidents and develop intelligent management of urban forest tree risk assessment through the combination of scientific data and information software. The outcome of the platform provides domestic industry, government, and academia with a tool to maintain urban forest, and with a database to establish analysis future big data. We expected this platform can strengthen the health management of urban forests and the development of resilient urban forests in Taiwan, and achieve the greening and ecological benefits of urban forests. The main tasks of this project in 2020 are described as follows: 1. Complete the biological and non-biological factors analysis and evaluation of the urban forest. 2. Establish an urban forest health assessment form and weight analysis. 3. Establish grading standards for urban forest tree health assessment. 4. Establish a forest health management information platform and establish tree health classification, the health classification includes: small planting holes, soil compaction, leaves yellowing, codominant Trunks, the withered of branches and leaves, brown root diseases, etc. At the same time, a database of 100 old trees and 1,000 trees has been established. 5. A total of 4 seminars and lectures related to urban forests were handled.

Key word: Tree risk assessment, Tree health assessment, Management for urban forest

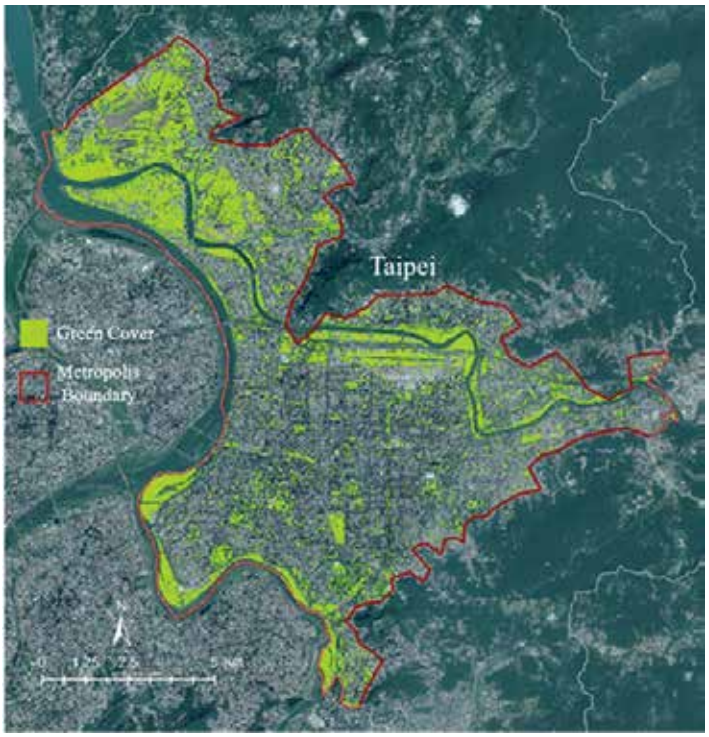
圖 2. 109年度植栽及樹木之健檢與醫療研討會主辦單位合照。

Fig. 2. Group photo of the organizers at the Seminar on Health Examination and Medical Therapy for Plants and Trees in 2020.

應用福衛五號衛星影像分析六都都會區綠覆率

謝漢欽、李隆恩、彭炳勳

都市綠覆率可用於反映一個城市都會區的居住環境品質，且具多元生態系統服務的效益與價值。本研究以臺灣六都的都會區為研究對象，採用2019年至2020年初拍攝無雲覆蓋的福衛五號衛星多光譜及全色影像，經過影像前處理與影像全色融合銳化後，建立NDVI影像。使用平均值調整影像分割法分類NDVI影像，萃取六都都會區的綠色植生覆蓋區域，並以分層逢機樣點進行綠色植生覆蓋區萃取精度評估，結果六都都會區萃取總體精度介於84%至91%之間。以總綠色植生覆蓋面積與都會區面積的比值，求得六都都會區的綠覆率，結果以臺南市的綠覆率32%最高，臺中市、高雄市、臺北市的綠覆率皆低於21%；其中新北市綠覆率最低只有15%。以六都度會區的總人口數，求得六都都會區的人均綠覆面積，結果以臺南市75 m^2/人為最高，高雄市、臺中市及桃園市接近20 m^2/人，因新北市及臺北市人口較多，其人均綠覆面積皆低於10 m^2/人以下。本研究成果為都市綠資源調查的重要項目，有利於都市林的監測與管理。



台北市都會區綠地覆蓋分布圖，底圖為2019年福衛五號正射影像鑲嵌圖。
The green cover map of the metropolis of Taipei City, the base image was a mosaic of Formosat-5 imagery collected in 2019.

Using Formosat-5 Images to Analyze Green Cover Rate in Six Major Metropolitan Districts

Han-Ching Hsieh, Long-En Li, Bing-Syun Peng

Urban green cover rate (GCR) can be used to reflect quality of living environment of an urban metropolitan district and has the benefits and value related to multiple ecosystem services. This study aimed at the metropolitan districts of six major cities in Taiwan, and the cloud-free multi-spectral and panchromatic Formosat-5 images from 2019 to early 2020 were chosen as experimental material. After image pre-processing and image panchromatic fusion, the normalized difference vegetation index (NDVI) images were established for green cover areas extractions. The image segmentation with object-based mean shift algorithm was applied to classifying NDVI images and extracting the green cover areas of the six metropolitan districts respectively, and stratified random sampling points were selected for accessing the accuracy of each extraction. The results show that the overall accuracies of metropolitan district of six major cities are between 84% and 91%. Divided the total area of green cover areas by the whole area of metropolitan district, the GCR of each metropolitan district was obtained. The results show that Tainan City has the highest GCR of 32%. Taichung City, Kaohsiung City, and Taipei City all have less than 21% GCR, and New Taipei City has the lowest GCR of 15%. According to the total population of metropolitan district of each city, the per capita green cover area of the metropolitan district was calculated. The results show that Tainan City is the highest at 75 m^2 per person, while Kaohsiung City, Taichung City and Taoyuan City are close to 20 m^2 per person. Due to New Taipei City and Taipei City with larger population, the per capita green cover areas are both less than 10 m^2 per person. Because GCR is an important baseline data for the inventory of urban green resources, the outcomes of this study will be beneficial to the monitoring and management of urban forests.

強化農業創新育成多元服務與建構行銷能量平台

柯淑惠、謝宛蓁、劉一新

本計畫的宗旨是透過建構行銷能量平台來強化與協助農業創新育成的多元服務，藉由農業委員會所屬創新育成中心及農科院育成中心的聯盟，共同推動發展農業領域之創業育成，協助農企業成長並厚植創新能量，掌握契機。行政院農業委員會為協助台灣農企業升級轉型並增加創新能量，於農業試驗所、林業試驗所、水產試驗所及畜產試驗所成立創新育成中心。育成中心擁有多元的服務平台，藉由有效資源整合共同創造良好環境，並建立北中南區全育成服務網絡，達成前育成至後育成一條龍式之完整服務。本年度農業創新育成中心定期於每季召開工作小組會議，以討論並促進各項工作的進行。為讓業者能即時獲得整合性資源輔導，辦理了一系列的課程講座，內容包含企業診斷、財務、技術移轉、市場行銷、經營管理以及定點諮詢等服務。109年度透過線上資源聯合說明會，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。並以深厚的農業研發實力，吸引具有潛力的業者進駐合作。本年度新進駐業者共13家，累積輔導152家業者。成功協助進駐業者申請通過產學合作計畫1件以及其他政府補助計畫5件(包含地方型SBIR、農業業界科專、智慧農業4.0業界參與補助計畫)；促進投資98,000千元以上；增加就業人數140人；輔導業者參展19場；共計20件技術移轉，授權金額5,161千元。

109年畢業廠商授證儀式。
Graduation Ceremony in 109.

Diversity enhancement of agricultural innovation incubation service and platform construction for marketing power accumulation.

Shu-Hui Ko, Wan-Chen Hsieh, I-Hsin Liu

The mission of this program is to assist in the development of the diverse service network by constructing a platform for marketing power accumulation in agricultural innovation incubation ecology, through the agricultural innovation incubation center (IIC) union. The aim of the incubators is to facilitate the survival of such companies and also to nurture these companies for growth and success.

Council of Agriculture, Executive Yuan has set up Taiwan Agricultural Research Institute, Forestry Research Institute, Fisheries Research Institute and Livestock Research Institute innovation incubation centers to help agricultural enterprises with innovating and commercializing agricultural technologies. The incubation centers provide not only well-up-pointed space, devices and technology, but also assist in capital attracting, business service and management. They effectively employ resources, lower the risk of start-ups in research cost, create good cultivation environment, and increase the chance of successfully running business.

Working Group meeting, held regularly every quarter of this year, promote and present modifications, review points, train the management and evaluation points, set points, and make the application process more convenient. In order to provide industry professionals with instant access to integrated resource counseling, a series of course lectures were conducted, which included services such as enterprise diagnostics, finance, technology transfer, marketing, business management, and on-site consulting.

Through the online platform introduces the agribusiness counseling resources joint briefings, joint investment promotion, publicity and promotional activities were accomplished. And, hence, value added to research findings, academia cooperation, agricultural technology development program, breeding centers and agribusiness counseling and other programs were explained.

This year 13 business firms were added to agricultural IIC and totally 152 stationed industries were advised. Our agricultural IIC assisted the industries to successfully apply the industry-research cooperation plan for 1 cases, also Government grants plans for 5 cases (including the Local SBIR, Agriculture Industry science, smart agriculture 4.0 industry participation subsidy program, etc.), investment boosted over NTD98 million; besides, employment of 140 people was promoted; tutoring for 19 companies to participate in the exhibition; technology transfer to the agricultural IIC business firms for 20 cases, total license fee amount for NTD5.1 million.

應用竹加工剩餘資材產製燃料顆粒計畫

林裕仁

以木質材料作為生質能是目前歐美國家政策極力推廣應用之再生能源，尤其廣泛地利用林木剩餘殘材製作木質燃料顆粒，作為替代化石燃料用於電力能源之運作。臺灣目前因林業以保育為主之政策，缺乏充裕之木質資材資源，然擁有豐富竹林資源與竹加工剩餘資材。本計畫以本所既有產製竹質燃料顆粒技術與經驗，以竹質剩餘資材取代木質原料產製竹質燃料顆粒，技術包含：料源評估、產能規劃、製程與場域設計、製程設備規劃與設置、作業效率與品質管理等技術。製程包括：原料貯存、分類、粉碎、研磨、乾燥、造粒(製棒)、冷卻、產品分級、包裝等作業程序。本計畫協助合作業者完成竹燃料棒製程所需粉碎、乾燥及造粒設備之安裝及試俥作業，並協助提升竹質燃料顆粒製程效益。計畫同時以「竹質燃料顆粒(棒)產製技術」為題申請非專屬技術轉移授權案，業經行政院農業委員會農業智慧財產權審議會議通過。舉辦示範觀摩會，分享與推廣竹加工剩餘資材再利用，製作加值提升之竹質燃料顆粒成果。本計畫創造剩餘資材附加產值，解決竹加工業者目前面對加工廢棄資材長期堆積無法去化，衍生之環境與產業經營困境等問題，增加竹材使用之經濟誘因，間接提升竹農經營竹林意願，改善竹林資源被荒廢困境，也同時發揮循環經濟，間接推動再生能源，達到善盡資源利用、創造經濟產值與環保等多重貢獻。

應用竹加工剩餘資材產製竹質燃料顆粒，具有善盡資源利用、創造經濟產值與環保等多重功能。
The bamboo fuel pellets produced using the bamboo residues from general bamboo processing industry, what possess multiple benefits on resource utilization, economic creation and environmental protection.

A project to product bamboo fuel pellets using residue from bamboo product processing

Yu-Jen Lin

Woody materials as renewable bioenergy, particularly wood pellet produced by forest residues, instead of fossil fuels for electric energy current is the main energy policy on European and American countries. Taiwan current is lack of sufficient woody resources to make wood fuel pellet due to the forestry policy focus on conservation since last decades. However, Taiwan has abundant bamboo forest resources and residues from bamboo processing industry. The project applied the existing experience and technology on the researches of bamboo fuel pellets, replaces woody residues with bamboo residues to produce bamboo fuel pellets. The techniques including: feedstock source evaluation, capacity planning, manufacturing process and field design, equipment planning and setting, operation efficiency and quality management, …etc. The manufacture procedures including: feedstock storage, classification, crushing, grinding, drying, pelletizing (or briquette making), cooling, product classify, packaging and other procedures. The project assisted cooperators completing the installation and trial operation of the crushing, drying and pelletizing equipment, and assisted improving the efficiency of manufacturing process. The project was also developing a non-exclusive technique transfer case on a title " Bamboo fuel pellet (briquette) production technique ", that got approved by the Agricultural Intellectual Property Rights Committee of the Agriculture of Council, Executive Yuan. To promote the implement results on application of bamboo residues by bamboo processing, a demonstration activity was held in the cooperator factory. The project created value-added products using bamboo residues, that solved the operational and environmental problems of bamboo processing industry what are facing on residues accumulation after long-term processed and hard be eliminated. Because bamboo fuel pellet could increase economic benefits, it would be good incentives for increasing bamboo utilization, furthermore, indirectly increase the willingness of manage bamboo forests to bamboo farmers, to improve the plight of bamboo forest resources being abandoned, and to exert the circular economy at the same time. In addition, the results could indirectly be to encourage renewable energy application, and to obtain multiple benefits on environmental protection, resource utilization and economic creation.

林園療育生態服務產業及效益之研究

徐孟豪、蔡宇平、吳孟玲

面對劇烈的氣候變遷、都市化現象、與人口老化問題，全世界皆在尋求因應方案。臺灣同樣面臨青年及中壯年人工作和生活的負擔與日俱增，社會所面對的慢性壓力及其衍生的身心疾病健康議題伴隨而至。臺灣豐富的林園療育資源結合休閒活動產業成為一個可嘗試用以解決前述問題的方案，由於森林環境物理條件上的空氣品質、動植物、水流與地質地貌都是恢復身心健康的良好條件，提供民眾自由放鬆、脫離日常繁瑣、與體驗休閒的機會。透過配置地區性的休閒遊憩活動規畫專業人員，促進社會互動與關係建立，亦是國際上興起的新趨勢。因此，本計畫於進行林園療育生態產業的開發研究，除廣泛探討國際上推行森林療育結合休閒活動進入地方永續產業之案例與推動情形外，整合森林療育資源與園藝治療理論，透過林業試驗所豐富的森林場域及專業人力資源，實際操作促進國內森林療育產業永續發展，期能提高全體國民健康福祉。在全球新冠肺炎疫情嚴峻之下，為減少人際間接觸機會，本研究透過線上問卷的方式比較人對不同環境樣貌的情緒、偏好與感受差異。結果發現，具有水景元素或同質性林木的環境比人工設施或未整理過的森林環境，更能令人感到愉悅與受大家喜愛，且這種同質性林木的型態能讓人感受到生物的多樣性、受保護以及寧靜的感覺，最具療育恢復的潛力。

環境心理效益評估線上問卷。
Online assessment of psychological benefit of environment.

The ecological and therapy benefits of forest industry

Meng-Hao Hsu, Yu-Ping Tsai and Meng-Ling Wu

Under increasingly drastic climate change, urbanization, and social isolation, it is urgent to seek solutions to these global challenges. In Taiwan, young and middle-aged person must cope with various stresses in fast-paced work and life, and may contribute to some physical and psychological health problems. Thanks to the richness of resources in Taiwan forests, it may provide an opportunity to let people to contact the natural environment and thus feel relaxed, being away, and do leisure activities. Through training forest therapy activity guides and arranging these well-trained specialists in rural areas, it can develop districts' economic localization. It is not only following international development trends, but also improving social relationship in the community. The goal of this project was focused on the healing effects of forest. First, using the ecological service assessment system to examine forest environments. Second, using psycho-physiological measurements to analyze health benefits of forest therapy activities. Third, integrated forest resources and the professional guides to promote the sustainable development of domestic forest therapy industry. It is expected that this ecological industry will reduce residents' stress and serve as the solution to establish a healthy society. Under the severe global epidemic of COVID-19, in order to reduce the chance of interpersonal contact, this study uses online questionnaires to compare people's emotions, preferences, and feelings for different environmental appearances. The results found that people feel happy and prefer the environment with water features or homogeneous forest than artificial facilities or unorganized forest. Moreover, people could perceive rich in species, refuge, and serene sense of feeling from homogeneous forest which provides more opportunity for healing and recovery stress.

受威脅植物遷地保存策略與植物園管理國際交流計畫

董景生

本計畫目的為持續與英國皇家邱植物園(Royal botanic Garden, Kew)聯繫以確定未來交流模式。原定透過派員赴英國皇家邱植物園進行實質交流工作，開拓植物園營運視野、強化植物園專業人力素質和建立稀有植物物種保育策略，提升臺灣對稀有植物特性評估能力以及植物園保育能力和教育推廣功能。

然而，2020年因應嚴重特殊傳染性肺炎(Coronavirus disease 2019, COVID-19)疫情影響，使得原定實質交流工作無法執行，於是修改工作目標。首先保持英國皇家邱植物園交流，透過建立具體合作事項和研擬未來合作模式，並協助英國皇家植物園植物標本館，進行臺灣植物標本數位化和鑑定，聆聽「世界植物與真菌狀態(State of the World's Plants and Fungi 2020)」線上研討會。

為了強化植物園管理人員的知識及技能，舉辦六場不同面向的員工教育培訓活動，以及一場位於惠蓀林場的植物展示及苗圃參訪活動。另外，藉由探討各國植物園展覽活動類型，規劃未來與鄰近館舍共同合作模式，強化台北植物園與各方的連結，並建立出屬於台北植物園的展覽活動。

同時也持續進行台北植物園稀有植物的監測工作和關注臺灣受威脅植物的採集與保存，盼未來疫情趨緩後，能與英國皇家植物園進行人員進行互訪的實地合作交流和工作坊的辦理。

圖 1. 邀集全臺植物園夥伴於惠蓀林場舉辦研討會及工作坊。
Fig. 1. Seminar on threatened plants conservation at Huisun Experimental Forest StationForest Health Management Information Platform.

International Exchange Program of Threatened Plant Conservation Strategy and Botanical Garden Management

Gene-Sheng Tung

The aim of this project is to keep in contact with the Royal Botanic Garden (Kew) to establish the joint works for both parties. The project was originally planned to send staff to the Royal Botanic Garden to carry out substantive exchange task, in order to broaden the staff's vision of botanical garden management, strengthen their professional quality, and learn from international practices to establish rare plant species conservation strategies. Also, enhance the characteristic assessing ability of rare plant in Taiwan.

However, in early 2020, the original project could not be implemented due to Coronavirus disease 2019 (COVID-19). Therefore, the project had been revised to maintain the communication with the Royal Botanic Garden, Kew, assist in the digitization and identification of Taiwan specimens in the Herbarium of the Royal Botanic Garden, establish the specific work items and draw up future cooperation models, and listen to in the "State of the World's Plants and Fungi 2020" online seminar.

To strengthen the knowledge and skills of staff in the Taipei Botanical Garden, a total of six employee education and training activities and a plant displaying and nursery visiting activity at the Huisun Experimental Forest Station had been held.

In addition, by exploring the botanical exhibition in various countries, we hope to explore possible future cooperation models with neighboring cultural venues, strengthen the connection between the Taipei Botanical Garden and all parties, and establish an exhibition activity belonging to the Taipei Botanical Garden.

At the same time, we continue monitoring rare plants in the Taipei Botanical Garden and paying attention to the collection and preservation of threatened plants in Taiwan. We hope that we can carry out substantive exchange task and establish workshops as the original project when the epidemic eases in the future.

圖 2. 辦理植物保種教育訓練課程。
Fig. 2. Educational program on threatened plants conservation.

建立強風豪雨對樹木生長逆境抵抗反應及管理方案

林振榮、李志璇、林柏亨、廖和順

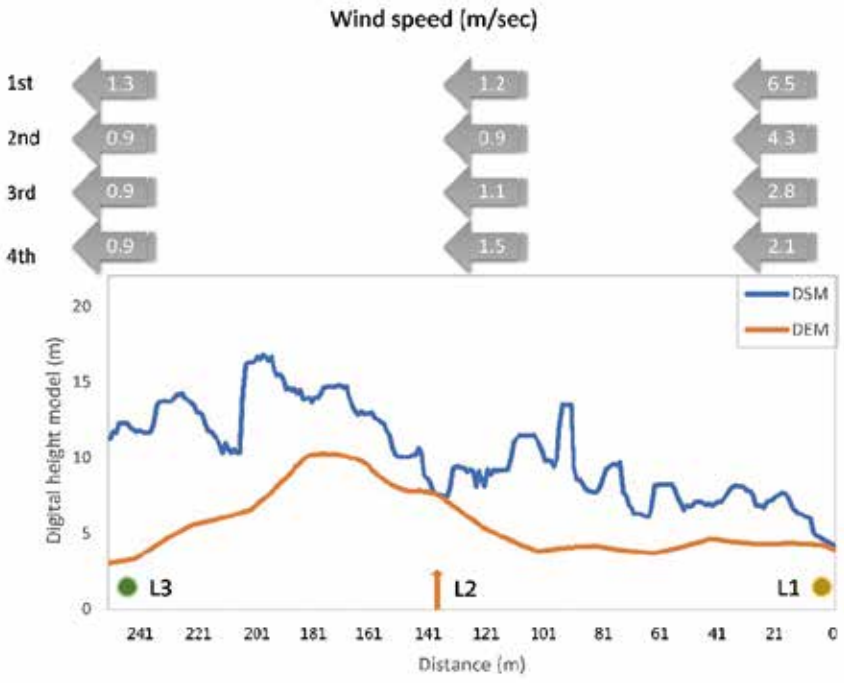
有鑑於氣候快速變遷持續進展與無法迴避，海岸林長期受到天然干擾破壞及人為開發壓力，對於海岸林應有的配置區位及其壓力來源均應釐清。近年來侵襲台灣的颱風危害有逐年變多、變強之趨勢，海岸林作為沿海地區的第一道屏障，可保護沿海地區農作物及地區人民財產安全，往往農作物收成之盛衰與海岸林之保護情形有很大之關係，也可降低強風直接侵襲的程度，減少當地居民生活的風險。本研究選定宜蘭壯圍海岸防風林為研究樣區，規劃三條樣線，分別為沿海樣線、自行車道、靠內陸之農田，並進行海岸林試區現況分析，包括環境因子、樹種組成、樹木基礎資料。已完成風速測定、土壤電導度資料蒐集與鄰近氣象站資料蒐集。透過調查氣候因子(如風速、土壤鹽分與氣候等極端天氣因子)，並分析其與林木外觀特性、適應性與生長等參數的關聯性，歸納出樹木風倒及破壞原因。藉由地理資訊系統將各項氣候因子與海岸防風林影像圖資整合套疊，搭配影像資料的分析，進行林地全盤了解，來探討強風、豪雨及其他地理環境條件等極端因子，對沿海地區樹種之影響，由此結果初步來研擬因應氣候變遷對林木所帶來之衝擊，並提出預防減災策略，藉以研擬不同目標之最適經營方式，逐步歸納提出調適管理建議。本計畫初步以樹木健全性檢查的VTA及NDT導入技術，評估樹木或樹種的生長逆境抵抗反應，並試圖將空拍機拍攝影像做預備試驗應用，並以壯圍防風林試區為例進行，透過調查及文獻彙整資料，陸續建置樹木健全性資訊於知識平台中。

宜蘭壯圍海岸林試驗地。
Yilan Zhuangwei Coastal Forest Test Site.

Establishing strong wind and heavy rain response to Coastal Windbreak tree stress resistance and management information

Cheng-Jung Lin, Chih-Hsuan Lee, Po-Heng Lin, Ho-Shun Liao

In view of the continuous progress of rapid climate change and the unavoidable, coastal forests have been subject to natural disturbances and damages and pressure from man-made development over a long period of time. The location and pressure sources of coastal forests should be clarified. In recent years, the damage of typhoons that have invaded Taiwan has been increasing and becoming stronger year by year. As the first barrier of coastal areas, coastal forests can protect the safety of crops in coastal areas and local people's property. The prosperity and decline of crop harvests and the protection of coastal forests are often It has a great relationship, and it can also reduce the degree of direct attack by strong winds and reduce the risk of local residents' lives. In this study, Ilan Zhuangwei coastal windbreak forest was selected as the research sample area, and three sample lines were planned, namely coastal sample line, bicycle lane, and inland farmland. The current situation of coastal forest trial area was analyzed, including environmental factors, tree species composition, and trees. Basic information. Wind speed measurement, soil electrical conductivity data collection, and data collection from neighboring weather stations have been completed. By investigating climate factors (such as extreme weather factors such as wind speed, soil salinity and climate), and analyzing their correlation with the appearance characteristics, adaptability and growth of trees, the reasons for windfall and damage of trees are summarized. Integrate and overlay various climatic factors with coastal windbreak forest image data through geographic information system, and analyze the image data to conduct a comprehensive understanding of the forest land to explore extreme factors such as strong winds, torrential rains and other geographical environmental conditions. As a result, we can study the impact of climate change on forests and propose disaster prevention and mitigation strategies to develop optimal management methods for different goals. This project initially uses the VTA method and NDT method for tree health inspection to evaluate the growth resistance of trees or tree species, and attempts to use aerial camera images for preliminary test applications, and take the Zhuangwei windbreak forest test area as an example Through surveys and document compilation, information on tree health is established in the knowledge platform.



樹冠高程模型剖面與風速變化圖(第8樣點)。
Tree crown elevation model profile and wind speed change graph (sample point no. 8).

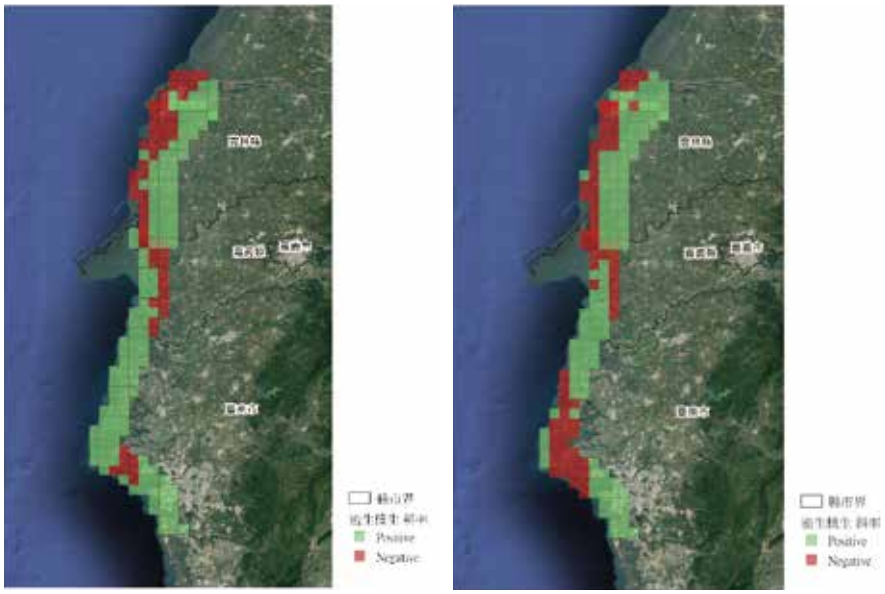
海岸林重要造林樹種因應氣候變遷之風險評估研究

曾俊偉

海岸林為沿海地區的第一道屏障，可降低強風直接侵襲的程度與減少當地居民生活及生產的風險，但近年來受到全球氣候變遷加劇影響，極端氣象事件有逐年變多、變強之趨勢，而海岸林在長期受到天然干擾破壞及人為的開發壓力下，呈現林分不易天然更新且逐漸衰退的情形，因此有必要對海岸林之潛在的衰退風險來源予以釐清。

本研究應用2000年1月至2019年12月之衛星影像資料分析雲林縣、嘉義縣及臺南市之海岸防風林變遷，監測防風林帶之消長及其周圍土地利用變異，並對重要區位之整體環境影響因子，進行整合性之評估，建立大尺度的海岸林監測系統，整建海岸林衰退及變遷圖資製作，並透過「代表濃度途徑」(RCP，指不同程度暖化路徑的人為溫室氣體排放量「情境假設」)情境模擬的方式預測未來防風林之空間分佈，藉以瞭解氣候變遷對海岸林環境資源的影響。

研究結果顯示，利用聯合國政府間氣候變遷委員會(IPCC)之第5次評估報告(AR5)之RCP模擬分析自2020年至2050年間海岸林衰退及變遷結果，3縣市總體的海岸林面積，在氣候變遷的狀態下呈現增加的趨勢，灌木、草生地或農作物面積則是呈現下降的趨勢。利用隨機森林模式評估2020年至2050年時在RCP2.6與RCP8.5情境下的變化趨勢，在雲林縣的沿海地區的密生植生面積呈現較多下降趨勢。灌木、草生地或農作物同樣較多下降趨勢出現在雲林縣的沿海區域，嘉義縣則維持較為穩定的情況，台南市在七股區與安南區則較多面積呈現下降趨勢。



在RCP2.6(左)與 RCP8.5(右)情境模擬的海岸林(密生植生)面積變化Simulation of coastal forest area change in rcp2.6 (left) and rcp8.5 (right) scenarios (在IPCC的第5次評估報告中，定義4組情境稱為「代表濃度途徑(RCPs)」，作為氣候模式進行數值模擬(未來氣候推估)的規範。這4組代表濃度途徑是描述4種不同溫室氣體排放、空氣污染排放和土地使用條件下的21世紀情境。4組代表濃度途徑中，RCP2.6是極低輻射強迫的減緩情境；RCP4.5與RCP6.0是中等穩定化的情境；RCP8.5是溫室氣體高度排放的情境。)
(In the fifth assessment report of IPCC, four scenarios are defined as "representative concentration pathways (RCPs)", which are used as the norms for numerical simulation (future climate estimation) of climate models. The four representative concentration pathways describe the 21st century scenarios under four different greenhouse gas emissions, air pollution emissions and land use conditions. Among the four representative concentration pathways, rcp2.6 was the mitigation scenario of very low radiation forcing; Rcp4.5 and rcp6.0 are moderately stable situations; Rcp8.5 is a high emission scenario of greenhouse gases.)

Risk assessment of important afforestation tree species in coastal forests in response to climate change

Chun-Wei Tseng

Coastal forests are the first barrier of coastal areas, which can reduce the degree of direct invasion of strong wind and the risk of local residents' life and production. However, in recent years, under the influence of global climate change, extreme weather events have become more and more intense year by year. Under the long-term natural disturbance and man-made development pressure, coastal forest is not easy to natural regeneration and has gradually declined. Therefore, it is necessary to clarify the potential sources of decline risk of coastal forest.

In this study, satellite images from January 2000 to December 2019 were used to analyze the changes of coastal windbreaks in Yunlin County, Chiayi County and Tainan City, to monitor the growth and decline of windbreaks and the variation of land use around them, to evaluate the overall environmental impact factors of important locations, to establish a large-scale coastal forest monitoring system, and to map the decline and change of coastal forests, In order to understand the impact of climate change on coastal forest resources, the spatial distribution of windbreaks in the future was predicted by simulation.

The results show that, using the "representative concentration pathway" (RCP, Scenario hypothesis of anthropogenic greenhouse gas emissions from different warming pathways) scenario simulation of the fifth assessment report (AR5) of the Intergovernmental Panel on climate change (IPCC) to analyze the decline and change of coastal forest from 2020 to 2050, the overall coastal forest area of the three counties and cities shows an increasing trend in the state of climate change The area of grass land or crop showed a downward trend. Based on the results of random forest model evaluation, the change trend of dense planting area in the coastal area of Yunlin County from 2020 to 2050 under rcp2.6 and rcp8.5 scenarios showed a more downward trend. There were also more shrubs, grass land or crops in the coastal area of Yunlin County, while the situation in Chiayi County remained relatively stable, and more areas in Qigu district and Annan District of Tainan City showed a downward trend.

區域性林業資材循環利用模式建立

林裕仁、何振隆、林振榮、徐光平

本計畫在遵循資源循環經濟理念，透過再思考、再循環、再利用及減量化的4R原則，發揮本所在木材物理與化學研究所累積的深厚基礎，運用精進創新技術將林業廢棄資材，製作成具生產性的生活用品。計畫結合創意設計思惟，利用造林木、受颱風影響產生之風倒木及漂流木、修剪作業產生之枝條材、木材加工業廠經常性產生之廢棄木質材料、木構房屋整建產生舊木料、及家庭產生舊家具等資材，進行木藝品之加值利用研發。此外，也使用樹木精油，如山胡椒、樟樹、土肉桂、白千層、真柏、澳洲茶樹等樹種，包括樹幹、枝條、葉子等，除分析其精油成分外，將可利用其精油化學成分萃製不同的精油配方產品，應用於生活用品之產業開發，例如完成防蚊產品、利用微膠囊技術包覆精油，結合印刷及設計，製作香氛精油桌曆、完成「紙溶你手-芳療紙香皂」生活產品開發，在疫情時代，市場接受度高。另計畫也擴展生物炭與木(竹)醋液能夠跨領域於畜產業應用，試驗生物炭與木(竹)醋液於畜禽養殖場，研發最適比例與用法，進行降低畜禽養殖場臭味之效益評估，試驗結果顯示，噴灑不同濃度之竹醋液於降低畜禽養殖場臭味與噴灑天數及竹醋液濃度具有顯著關係。本計畫執行過程均與業界合作，創新多元化利用林業資材，加值林產品利用，建置健全林業資材產銷管道，增加林業資材使用量，活化臺灣林產業發展。

萃取臺灣杉剩餘資材精油，開發「紙溶你手-芳療紙香皂」產品，在疫情時代，市場接受度高。

A product named "Paper Melting in Your Hands-Aromatherapy Soap" that is developed, which the essential oil extracted from Taiwania (*Taiwania cryptomerioides*) is admixed in the soap and soluble paper to form a “paper soap”. The creative product is highly accepted by consumer on the current market under the COVID-19 epidemic.

Establishing regional circular utilization model of forest materials

Yu-Jen Lin, Chen-Lung Ho, Cheng-Jung Lin, Kuang-Ping Hsu

The project followed circular economy principle and applied the 4R principles: rethink, recycle, reuse and reduce, exert the professional practices on wood physics and chemistry what are accumulated by researches on last years. The project also applied advanced techniques and innovative design, to create value-added products on daily necessities using forest residues such as: plantation wood, fallen trees, driftwood by typhoon, branches by pruning, wood residues by timber processing plants, old timber by wooden houses renovation, family old furniture, and other related wooden. In addition, this project also used tree essential oils from various tree species such as: mountain pepper, camphor, cinnamon, melaleuca, true cypress, Australian tea tree, using its trunks, branches, leaves, etc. The chemical components of these essential oil were analyzed and were extracted, and applied it on industrial development to make essential oil products for daily necessities such as: completed anti-mosquito products, combined printing and design making fragrance essential oil table calendars using microcapsule technology coating essential oils, and completed the product development of "paper soap" admixing the essential oil of Taiwania (*Taiwania cryptomerioides*) the title "Paper Melting in Your Hands-Aromatherapy Soap", the product is highly accepted by consumer on the current market under the COVID-19 epidemic. To expand the application of biochar and wood (bamboo) vinegar in the livestock industry, another work of this project was across fields making experiments with biochar and wood (bamboo) vinegar in livestock and poultry farms, developing the most appropriate ratio and usage effectiveness on odor eliminating. The results showed that different concentrations bamboo vinegar spraying has a significant relationship with the spraying days and the bamboo vinegar concentration in eliminating odor on livestock and poultry farms. The project implemented always cooperated with the industry, together to innovate value-added forest products under diversified use forest residues, and has constructed channels on production and sales for reusing forest residues that could increase forest residues utilization and could be useful to revitalize the forest industry in Taiwan.

區域性竹資源循環利用模式建構

何振隆、徐健國、徐光平、林裕仁、李志璇

本區域性竹資源循環利用模式建構計畫由竹資源於文化用紙產業之應用、廢棄竹資材製備環保燃料及區域能源設施展示、竹構建築之技術規範建立及示範展示等工作項目彙整而成。在竹資源於文化用紙產業之應用，本年度已完成竹漿鳳梨纖維及馬尼拉麻所抄製的複層紙，並完成複層紙之技術轉移。廢棄竹資材製備環保燃料及區域能源設施展示方面，本年度為完成協助竹山竹加工業者規畫製作「材料破碎機組系統」與「材料造粒/製棒機組系統」兩系統，並完成「竹質燃料顆粒(棒)產製技術」技轉。竹構建築之技術規範建立及示範展示研究方面，本年度為完成圓竹稈之物理及機械性質、竹構造接頭之類型及力學性質等，並已完成規畫竹構建築規範準則之籌議想定方向等。

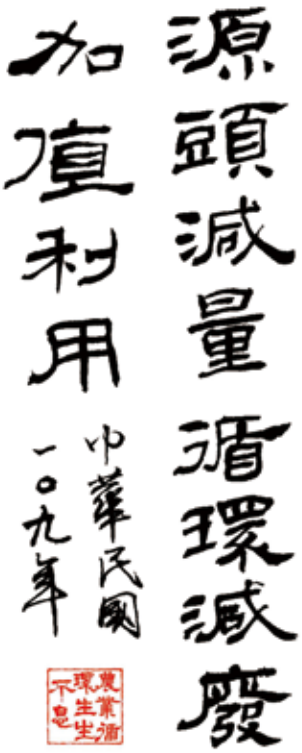


圖 1. 連史紙。
Fig. 1. Lienshih paper.

圖 2. 利用竹加工剩餘資材產製竹質燃料顆粒。
Fig. 2. Bamboo fuel pellet made by using bamboo processing residue.

Establishment of Local Bamboo Resource Recycling Utilization Model

Chen-Lung Ho, Jiann-Gwo Shyu, Kuang-Ping Hsu, Yu-Jen Lin, Jhih-Syuan Li

This project, “Establishment of Local Bamboo Resource Recycling Utilization Model,” includes applications of bamboo resources to papers for cultural industries, waste bamboo materials to prepare environmentally friendly fuels and regional energy facilities display, and establishment and display of techniques for bamboo-structured buildings. In applications of bamboo resources to papers for cultural industries, we have completed the multi-layer paper made of bamboo pulp, pineapple fiber, and manila hemp fiber, and completed the technology transfer of the multi-layer paper. In preparation of bamboo residue-based eco-fuel and exhibitions of local energy facilities, we have designed systems for shredding and granulation/stick making machines for bamboo processing plants in Zhushan Township. We have completed "bamboo fuel" technology transfer of granule (rod) production technology. In establishment and display of techniques for bamboo structured buildings, we have analyzed the physical and mechanical properties of round bamboo stalks, bamboo structural joints, etc., and the direction of planning the bamboo construction code guidelines has been completed.

木質廢棄資材加值應用模式建置

塗三賢、林振榮、林柏亨

如何提高木質廢棄物使用價值及利用是一個重要議題，本計畫使用回收杉木廢棄鋸屑，以15%重量比的杉木木粉與PLA聚乳酸混煉造粒，抽絲製作3D列印機使用的PLA/木粉纖維複合線材，完成線材中的木粉粒徑與固形分含量等線材的基本物性分析，自製線材的木粉粒徑平均約為71.1um，95%的粒徑小於190um，線材的熔融指數(MI)約為7.23，混煉後仿木線材的開始裂解溫度則約在250℃。以泡水24小時的方式進行列印試片的尺寸安定性檢測，結果顯示不同溫度列印對試片尺寸安定性的影響不明顯，另以回收木質廢棄物，列印層高愈大有愈佳的尺寸安定性，列印填充率愈大有愈佳的尺寸安定性。將木粉材料不同比例與PLA聚乳酸塑膠粒混合之配方混煉實驗，同時檢測複合材之熔融指數，判定其加工操作性，經檢測複合材之熔融指數後發現，在加入10%的澱粉基質後，各複合材的熔融指　均明顯降低，熔融指　平均降低約26.6%。功能性陪伴動物墊料之開發已完成材料基本性質(含水率、密度等)、造粒技術參數之檢測，試材之纖維素為44.94-53.71%，半纖維素為12.08-19.29%，木質素為31.93-35.14%，灰分為0.4-1.05%，醇苯抽出物為4.11-4.42%，添加多孔性炭材對於動物墊料中可提升動物墊料對2-醯基-3-丁醇吸附能力，即添加多孔性炭材的動物墊料可提升飼養陪伴動物共居環境品質。

木質廢棄物與PLA混煉製作的3D列印環保線材，賦予列印成品有木頭的質感。
The 3D printing filament made by recycled wood wastes and polylactic acid (PLA) plastic could give the printed product a woody texture.

Development on Value-added Application for Wood Wasted Resources

San-Hsien Tu, Cheng-Jung Lin, Po-Heng Lin

How to improve the use value and utilization of wood waste is an important issue. This study mixes recycled Chinese fir wood powder with polylactic acid (PLA) to make 3D printing filaments. Analyze the basic physical property, such as the particle size and solid content of the filament. The wood flour particle size of the self-made filament is about 71.1um on average, and 95% of the filament has a particle size less than 190um. The melt index (MI) is about 7.23, and the starting pyrolysis temperature of the wood-like wire after mixing is about 250°C. The dimensional stability of the printed test piece was tested by soaking in water for 24 hours. The results showed that printing at different temperatures has no obvious influence on the dimensional stability. In addition, increasing the printing layer height, would show better dimensional stability, the larger the print filling rate, the better the dimensional stability. Test of mixing wood powder material and 10% starch with PLA plastic, result shows the melt index of the composite material was significantly reduced, and the melt index decreased by about 26.6% on average. The development of functional companion animal bedding materials has completed the testing of the basic properties of the material (moisture content, density, etc.) and granulation technical parameters. The cellulose of the material is about 44.94-53.71%, the hemicellulose is 12.08-19.29%, and the lignin content is about 31.93-35.14%, the ash content is 0.4-1.05%, and the alcohol benzene extract is 4.11-4.42%. Adding porous carbon material can improve the adsorption capacity of the animal bedding material on 2-acyl-3-butanol. That is, animal bedding materials mixed with porous carbon material could improve the quality of the living environment of companion animals.

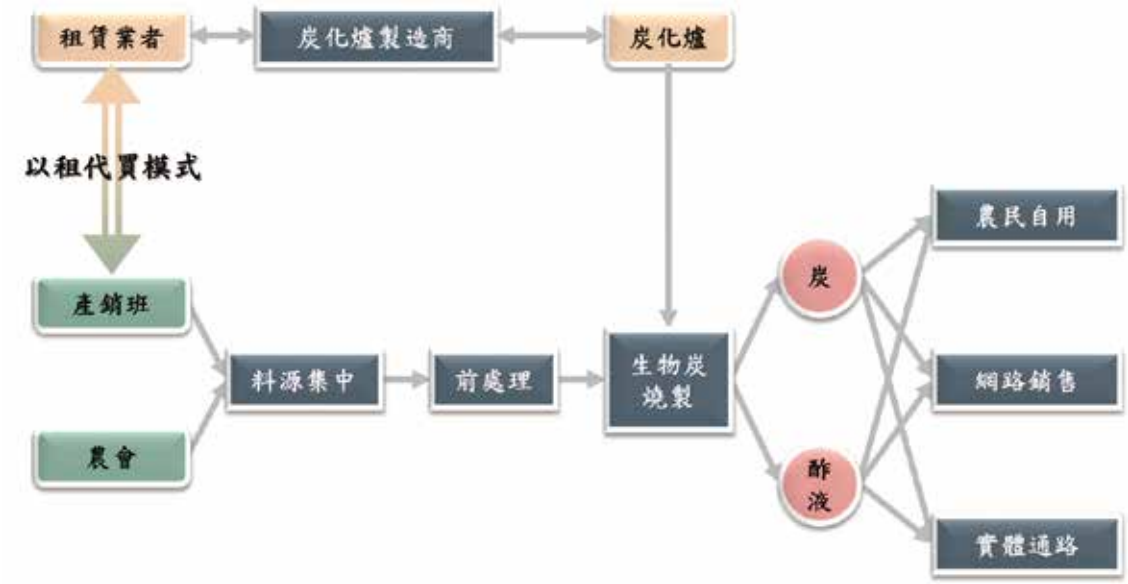
木質廢棄物與PLA混煉製作的3D列印環保線材，賦予列印成品有木頭的質感。

The 3D printing filament made by recycled wood wastes and polylactic acid (PLA) plastic could give the printed product a woody texture.

109年度生物炭料源供應及產製技術精進整合計畫

李志璇、林裕仁、林振榮

本計畫為委託計畫，試驗成果摘要如下：1.農林剩餘資材再利用北部產業鏈建構：推動農林剩餘資材循環利用，建立良好的社區生物炭微型產業的推動模式，推動農業循環或生物炭產業，辦理辦理社區農業循環微型產業人才培力班，進行鄉鎮或產銷班農業循環或生物炭產業可行性規劃。2.綠化植穴生物炭介質配方研發及應用商品化：針對生物炭與植穴常用介質及微生物製劑之添加進行評估，比較不同配方對於都市常見苗木與都市菜園作物之生長影響，以探討都市常見作物對於不同生物炭 介質配方的促進生長效果及防治線蟲的效果。3.農林剩餘資材能源、材料與飼料再利用產業鏈建構：由農林剩餘資材衍生產品需求端出發，媒合供給端與需求端，以確保農林剩餘資材衍生產品未來可行商業模式，以多元需求輔導農林剩餘資材多元再利用管道，協助解決農村問題。建立國內農林剩餘資材能源、材料與飼料再利用示範場域，促進企業投資。



生物炭產業鏈推動模式。
Promoting Model of Biochar Industry Chain.

Advanced integration of biochar source supply and production technology (2020)

Chih-Hsuan Lee, Yu-Ren Lin, Cheng-Jung Lin

This project is a commissioned project, and the test results are summarized as follows: 1. Reuse of surplus agricultural and forestry materials: Construction of the northern industrial chain: promote the recycling of surplus agricultural and forestry materials, establish a good community biochar micro-industry promotion model, and promote agricultural recycling or biochar Industry, handle the community agricultural recycling micro-industry talent training class, and carry out the feasibility plan of the agricultural recycling or biochar industry in the township or production and marketing group 2. Development and commercialization of biochar medium formulations for greening planting holes: evaluate the addition of biochar and common media and microbial agents for planting holes, and compare the effects of different formulations on the growth of common urban seedlings and urban vegetable garden crops to explore common urban The growth-promoting effect of crops on different biochar medium formulations and the effect of controlling nematodes. 3. Construction of the industrial chain for the reuse of agricultural and forestry surplus materials, energy, materials and feed: starting from the demand side of the agricultural and forestry surplus materials derivative products, matching the supply side and the demand side, to ensure the future viable business model of the agricultural and forestry surplus materials derivative products, and guidance with diversified needs Diversified reuse channels for surplus agricultural and forestry materials to help solve rural problems. Establish domestic agricultural and forestry surplus materials, energy, materials and feed reuse demonstration sites to promote corporate investment.

生物炭料源供應及應用管理平台建構

鄭美如、張哲彰、陳建文、詹為巽

本計畫為建構「生物炭料源供應及應用管理平台」，從資源分布、料源處理、處理現況到終端使用，透過收集、彙整農地及林地相關GIS圖資並進行分析與運算，以及掌握各項生物炭料源生產、回收、利用與通路，建構管控流程，調節資材生產預測與剩餘資材配置，推演最佳的動態料源供應與回收利用鏈，完整呈現台灣各類農業資源資材及廢料分布狀況，做為循環經濟與廢棄物循環利用與研究發展的相關政策依據，期能達到零廢棄、全循環的目標。此外，建立生物炭知識分享系統，提升產官學研各界及全民生物炭料源再利用之實踐與運用。本計畫分4年度規劃達成生物炭循環利用知識分享系統建立、國內生物炭料源供應資料庫及生物炭供應潛量分析、基於農林產業資源動態分布資料庫所建立之生物炭料源供應決策支援系統，以及生物炭料源供應及應用管理系統，並具可攜化的行動式設計，同時提供開放資料(open data)功能，促使農業剩餘資源循環利用資訊透明化及擴展利用性，進一步提升循環農業之產業的商機。

生物炭料源供應及應用管理平台宣傳單。
Flyer of the Biochar Materials Supply and Application Management Platform.

Establishment of Biochar Materials Supply and Application Management Platform

Meei-ru Jeng, Che-Chang Chang, Chien-Wen Chen, Wei-Hsun Chan

The project goal is to construct a management platform for biochar materials supply and application. From resources distribution, raw materials processing, processing situation, to the end-use, through collection, aggregation, analysis, and calculation of GIS data of agricultural land and forest land, obtains the various biochar materials production, recycling, use and access, then constructs control process flows, adjusts the production forecast and remnant material distribution. Hope to deduce adequate dynamic material supply and recycling chain, and presenting the complete distribution of various types of agricultural resources and waste materials in Taiwan, which will be the basic information of policies of recycling economy, waste recycling, and related researches, and achieve the goal of zero-waste, i.e. the whole cycle. Further, the biochar knowledge sharing system will be established to increase the practice and application of the biochar materials reuse.

This 4-year project achieved the establishment of the biochar materials recycling knowledge sharing system, database of domestic biochar materials supply and supply potential of biochar materials, the establishment of the decision supporting system of biochar materials supply, which bases on the dynamic distribution database of agricultural and forestry resources, and biochar materials supply and application management system. The supply chain management system can be used by mobile device, and all the data can be provided by open data function. This platform will enhance the business opportunities of the agriculture resource recycling industry.

109年度生物炭產品創新加值應用與終端利用效益評估計畫

李志璇、林裕仁、林振榮

本計畫為委託計畫，試驗成果摘要如下：1.先導型連續進料多膛爐製備大量生物炭技術開發計畫：利用農業剩餘資材，開發生物炭量產設備，製備生物炭作為土 壤改良材料之產品，以期能建立農業剩餘資材再利用之技術，並可藉以提高國內農業剩餘資材之利用效率。2.南臺灣農　剩餘資材產業平台產品開發及推廣：開發果木再利用生質顆粒配方與其生物炭(醋液):如原料前處理、集運條件、造粒處理、炭化製程等相關設備設置與效益評估。3.生物炭於活體水產動物運輸之應用：利用含生物炭的包裝 資材運用於活體水產動物的包裝運輸，以改善運輸期間的水質及降低動物死亡發生。4.都市林土壤施用生物炭之評估：將評估都市林受褐根病菌感染的土壤施用生物炭的效益，預期生物炭的特性搭配有機肥能降低褐根病菌對林木的危害。5.生物炭產業發展促進及研究成果產業應用：規劃協助林試所彙編與出版「台灣生物炭產製與農業應用指南」，期能提供 生物炭相關業者、農民與社會大眾正確生物炭使用方式，加強生物炭應用使用者認知並推動生物炭應用需求。6.評估以菇包廢棄物再利用之生物炭複合緩釋肥於土壤中的肥力釋放通量及其 效益：以生物炭配合堆肥(三種堆肥，分別為生物 酸性、生物中性與生物鹼性)進行造粒，分析該些複合資材於土壤中之礦化與養分分解狀況；同時，評估資材之緩釋效益(產量)。

各種生物炭複合資材造粒產品及應用。
Various biochar composite materials granulation products and applications.

Innovative value-added applications of biochar products and evaluation of end-use benefits (2020)

Chih-Hsuan Lee, Yu-Ren Lin, Cheng-Jung Lin

This project is a commissioned project, and the test results are summarized as follows: 1. Pilot-type continuous-feeding multi-hearth furnace to produce a large amount of biochar: Technology development plan: use agricultural surplus materials to develop biochar mass production equipment and prepare biochar for soil improvement The product of materials is expected to establish a technology for the reuse of agricultural surplus materials, and to improve the utilization efficiency of domestic agricultural surplus materials. 2. Southern Taiwan's agricultural and forestry surplus materials industry platform product development and promotion: development of fruit wood reuse bio-particle formula and biochar (vinegar liquid): such as raw material pretreatment, collection and transportation conditions, granulation treatment, carbonization process and other related equipment settings and benefits Evaluation. 3. Application of biochar in the transportation of live aquatic animals: packaging materials containing biochar are used for the packaging and transportation of live aquatic animals to improve water quality during transportation and reduce animal deaths. 4. Evaluation of the application of biochar in urban forest soil: The benefit of applying biochar to the soil infected by brown root pathogen in urban forest will be evaluated. It is expected that the characteristics of biochar combined with organic fertilizer can reduce the damage of brown root pathogen to forest trees. 5. Promotion of the development of the biochar industry and industrial application of research results: planning to assist the Forestry Laboratory to compile and publish the "Taiwan Biochar Production System and Agricultural Application Guide", hoping to provide biochar related businesses, farmers and the general public with the correct use of biochar, To enhance the user's awareness of biochar applications and promote the demand for biochar applications. 6. Assess the fertility release flux and benefits of the biochar compound slow-release fertilizer used for the reuse of mushroom bag waste in the soil: use biochar with composting (three types of compost, namely, bioacid, bioneutral and bioalkaline) Perform granulation to analyze the mineralization and nutrient decomposition status of the composite materials in the soil; at the same time, evaluate the slow-release benefits (yield) of the materials.

林業資材與木竹炭多元應用技術開發之研究

林裕仁 吳孟玲 陳財輝

生物炭結構具有多孔性，其表面積加總起來大，可吸附土壤養分使養分不易流失，也可增加土壤的保水力及通氣性，有助於延長肥效、減少肥料浪費。另外生物炭通常呈現微鹼性，可中和酸性土壤，用來作為栽培介質材料，因耐腐性佳，可長期使用，並可吸附各種養分，慢慢釋出供給作物養分。本計畫以添加不同比例生物炭進行都市林木與苗木的生長試驗，並整合樹木健康評估、土壤性質評估、生物炭性質與混合比例評估、生物炭與生物製劑配比評估與園藝工程施作規劃等技術，以「應用生物炭改良都市林土壤技術」為題通過技轉案申請，並完成商用技轉案簽約1件，該技術可調整都市內樹木土壤物理結構，提昇都市林土壤的通氣性、保水性及養分保存性，進而改善樹木的健康，增進抵抗遭受病蟲危害的免疫力。計畫同時分別針對針葉樹、耐陰性闊葉樹與非耐陰性闊葉樹，完成生物炭育苗育苗配方，並透過參加「2020台灣創新技術博覽會-永續發展館」展出，擴大推廣生物炭應用於土壤改良技術予社會大眾與相關業者，藉以增加推廣機會。且應用園藝工程技術進行生物炭的施用，提升生物炭的應用價值。

生物炭結合園藝工程改善都市林土壤性質與結構，促進林木健康生長。
Biochar application combined with horticultural engineering technique can improve the properties and structure of urban forest soil what is helpful to boost tree growth in good health.

Research and development for forest materials, wood & bamboo Charcoals multiuse

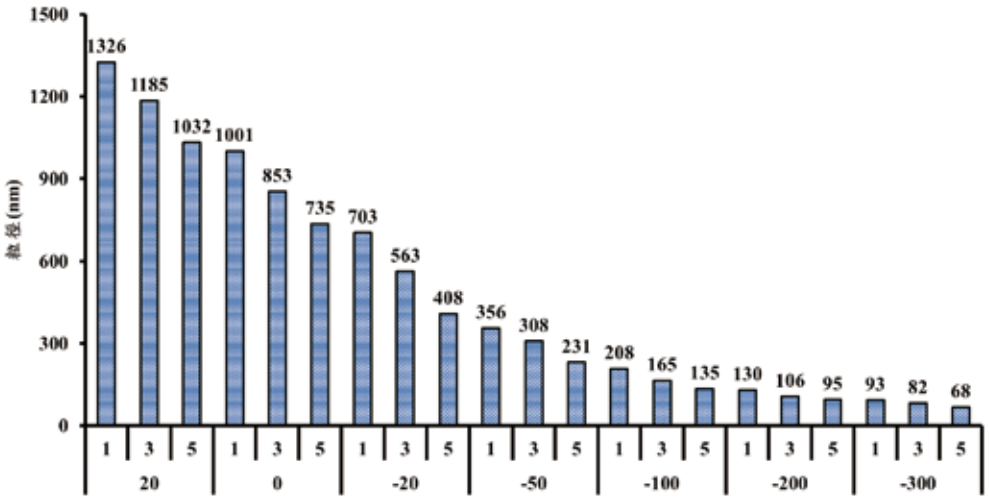
Yu-Jen Lin, Meng-Ling Wu, Tsai-Huei Chen

Biochar possesses the properties on porous large surface area what can absorb soil nutrients to avoid nutrients loss not easily. Biochar also can increase soil water retention and aeration, which helps to extend fertilizer efficiency and reduce fertilizer waste. In addition, biochar generally appears slightly alkaline and has good resistance on corrosion for long time, what integrated is useful to neutralize acidic soil, used as a cultivation medium material, and absorb various nutrients with slowly release function for crops. This project used biochar different proportions to research urban forest and seedling growth, and integrated tree health assessment, soil property assessment, biochar mixing ratio assessment based on its property, ratio assessment on biochar mixed biological agent, and horticultural engineering technique developing a technique transfer case on a title "Application of biochar to improve urban forest soil technique", that got approved and completed a commercial transfer agreement. The technique can adjust soil physical structure of urban trees, improve soil aeration, water retention and nutrient preservation, what thereby cam improve the health and enhancing immunity against pests and diseases of trees. At the same time, the project completed the biochar seedling breeding formula for conifers, negative-tolerant broad-leaved trees and non-negative-tolerant broad-leaved trees. In addition, to promote opportunities of biochar application on soil improvement technique, particularly combined on horticultural engineering, to general public and related businesses, the project participated the Exhibition on "2020 Taiwan Innovation Technology Expo – Sustainable Development Hall". This way is able to enhance the application value of biochar as well.

循環木質材料衍生物研發新型態包裝冷鏈資材

林柏亨、徐光平、何振隆、林振榮

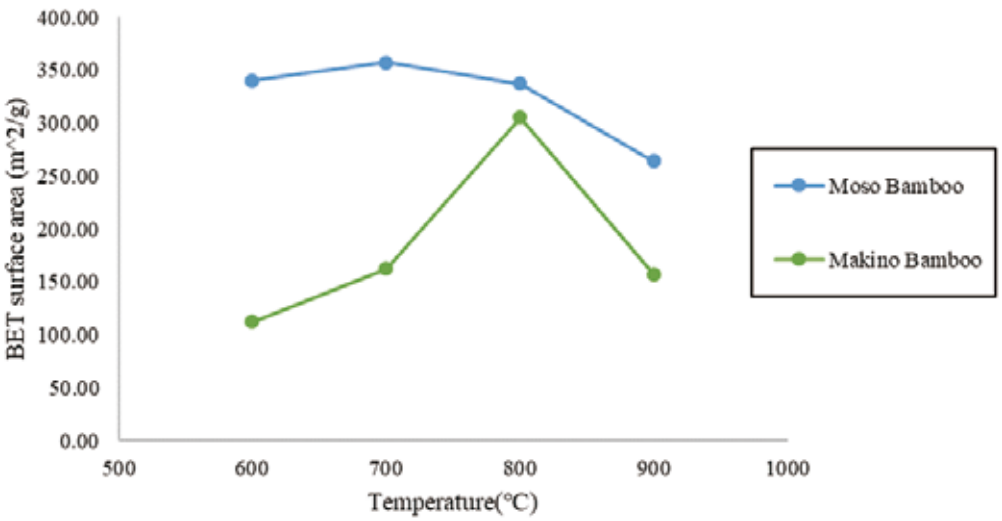
本計畫藉由篩選抗菌及無細胞毒性之植物抽出成分、木質微纖維運用於蔬果運輸儲存保鮮包裝紙箱袋更新及研發、木質多孔性循環碳材原料與製程參數等搭配之最佳吸附乙烯之組合等方向達成延長蔬果保鮮期限之目標。山茶科植物之葉部材料抽出成分萃取，收率為35.6%，經分離、純化、鑑定化合物及施作檢量線等試驗，以E成分最多，為48.00±1.61 mg/g。樟科樹種材料經由硫酸鹽製漿法蒸煮後，所得紙漿收率為40.8%，並以精磨機械法磨製奈米微纖維，其為隨著磨解次數及加壓增加，其所得粒徑愈小。孟宗竹(Moso Bamboo)在700℃ BET比表面積為357.05 m^2/g，孟宗竹竹炭與對照組使用日本市售保鮮劑A進行乙烯吸附，其結果與本試驗燒製孟宗竹竹炭進行比較，600℃乙烯吸附量與市售保鮮劑差距不大，但在700~900℃高溫燒製孟宗竹炭高於保鮮劑A 31.858 mg/g。



樟樹漿料利用精磨機械法磨製奈米微纖維之粒徑圖。
Grain size of nano-microfibers made from camphor paste by fine grinding machine.

Research and development for forest materials, wood & bamboo Charcoals multiuse

The project aims to extend the shelf life of fruits and vegetables by selecting antimicrobial and non-cytotoxic plant extracts, renewing and developing wood microfibers for transportation, storage and preservation of fruits and vegetables in cartons and bags, and combining wood porous recycled carbon materials with process parameters for optimal ethylene adsorption. The extractive yield of the leaf material of Camellia sinensis was 35.6%, and after separation, purification, identification of compounds, and application of a measuring line, the largest amount of component E was 48.00±1.61 mg/g. The yield of the pulp obtained from the pulp of Camphoraceae was 40.8% after steaming by sulfate pulping, and the nano-microfiber was milled mechanically by fine grinding, which was found to increase with the number of grinding cycles and pressure. The pulp yield was 40.8%, and the pulp was milled mechanically by fine grinding. The specific surface area of Moso Bamboo was 357.05 m^2/g at 700℃. The results of ethylene adsorption of Moso Bamboo charcoal were compared with those of the control group using commercially available preservative A. The difference between the adsorption of ethylene at 600℃ and the commercially available preservative was not significant, but the amount of ethylene adsorption at 700-900℃ was higher than that of the preservative A.



不同炭化溫度孟宗竹、桂竹比表面積(BET)分析結果圖。

Results of specific surface area (BET) analysis of Moso Bamboo and Makino Bamboo at different carbonization temperatures.

2020

Annual Report

參

附錄

Appendix

109年度 1月–12月

1 JAN

- 本所恆春研究中心1月5日於行政院農業委員會農業生物科技園區籌備處召開志工年會暨研習活動，此為志工團一年一度的盛會，共有志工及中心承辦人員計45位參加。
- 本所技術服務組於1月6日至8日辦理為期三天的「試驗林示範經營計畫」期末考察，辦理地點為太麻里研究中心及六龜研究中心，並於當地召開審查會議。
- 本所森林經營組1月13日至14日於福山研究中心舉辦「人機競技攀樹技能觀摩交流工作坊」，邀請專業攀樹師團隊介紹攀樹知識與設備，亦邀請臺灣大學機械系爬樹機器人研發團隊展示機器攀樹，雙方透過活動討論人機攀樹方式之差異，並共同研析未來強化攀樹機器效能之可行方向。
- 本所六龜研究中心於1月15日召開109年度第1次員工大會，由陳永修主任擔任主席，會中除針對108年度完成業務與109年度擬定之各項研究計畫進行討論外，亦介紹新進同仁予大家認識。
- 本所六龜研究中心陳永修主任規劃利用閒置空間建立木工藝教室，推廣國產木、竹材等之利用價值，增加森林生態教育之廣度。自109年1月31日起共計七次課程，培訓工藝種子教師志工。

2 FEB

- 本所六龜研究中心於2月8日至9日辦理扇平生態教育志工第一季專業訓練。
- 本所技術服務組於2月10日假本所行政大樓四樓會議室舉辦EML編輯軟體(Morpho)教學研習會。
- 本所育林組與六龜研究中心組成生長調查隊，於2月10日至14日與2月24日至26日完成多納20與24林班的生長調查。生長調查期間，張所長與游漢明組長，於2月13日由六龜研究中心陳永修主任陪同下，到24林班探視整個臺灣杉生長調查與選育的過程。
- 本所技術服務組於2月14日假本所行政大樓四樓會議室舉辦資通安全管理暨風險管理教育訓練。
- 本所技術服務組於2月25日邀請工業技術研究院楊思源組長蒞所演講，以增加同仁對於技術移轉之概念，了解技術移轉之策略與運作機制。

3 MAR

- 本所張彬所長3月3日率森林經營組及相關同仁前往農業試驗所協助危木風險檢測，檢測結果均未達危木等級，惟須注意病害防治以防患於未然，維護民眾安全。
- 本所太麻里研究中心以「太麻里地區蛾類、甲蟲類及植物種子標本展示」為主題，3月7日參與林務局臺東林區管理處及臺東縣政府在臺東森林公園主辦之臺東縣區域

植、護樹及森活市集活動，並由中心主任率領同仁向民眾解說與展示主題有關的自然生態常識。

- 本所於3月19日起，由技術服務組配合所外第三方驗證公司進行為期兩天的資訊安全管理系統實質驗證審查；今年是第三度辦理，驗證審查重點分就組織層面、管理執行層面及資訊機房三大部分進行。
- 本所中埔研究中心3月22日參與嘉義縣政府於民雄鄉福樂公園辦理之109年植樹活動，以植栽綠美化栽培管理為題，配合進行林業技術推廣活動，吸引超過250人次參訪。
- 本所福山研究中心3月23日至24日在福山植物園辦理植物園樹木修剪訓練班，特別邀請日本國文化協會認證樹醫、現任社團法人臺灣都市林健康美化協會秘書長李碧峰先生團隊，針對林業試驗所植物園管理相關主管及人員進行學理與實務訓練，參訓人數為32人。

4 APR

- 本所太麻里研究中心於4月1日起協助辦理臺東縣金峰鄉嘉蘭社區發展協會執行林務局臺東林區管理處社區林業計畫—「109年度嘉蘭部落巡護山林工作計畫」，擔任相關課程講師及協同山林巡護工作。
- 雲林縣政府與古坑鄉公所4月11日至12日，在古坑鄉荷苞山桐花公園辦理一場桐花祭活動，本所中埔研究中心也受邀配合，辦理相關林業技術推廣宣導活動。
- 4月15日張彬所長率領韌性都市林團隊在109年所選定的韌性都市林示範區新北市中和四號公園種植12種臺灣原生喬木樹種逐步建構都市複層林，提升周邊的韌性。
- 本所農業創新育成中心分別於4月15日及22日邀請青年創業協會總會顧問邱鴻祥博士，假本所和平辦公大樓1樓會議室進行「培育廠商個案輔導診斷諮詢」，以增進育成廠商之輔導深度與廣度。
- 雲林縣四湖鄉四湖國小師生約50人，於4月19日騎腳踏車至四湖海岸植物園，辦理該校六年級學生「109年度鐵馬小勇士」活動，由中埔研究中心蔡景株助理研究員負責帶領導覽，讓四湖國小師生有著不一樣的畢業之行。
- 本所於4月21日參與行政院農業委員會林務局於墾丁國家公園管理處舉辦之「墾丁國家公園復育臺灣梅花鹿經營管理專案小組會議」，一同商議「復育之梅花鹿經營管理方向及評估指標建立」，另針對本所轄管之墾丁高位珊瑚礁自然保留區受梅花鹿危害之情形，進行解決方法的研擬及討論。
- 本所於4月22日至5月10日與行政院農業委員會林務局新竹林區管理處、厚食聚落、財團法人梧桐環境整合基金會共同舉辦「食物×森林—聚落特展」，介紹什麼是食物森林、森活藝術、感官療癒、林下採集、種子是森林的起源等活動內容。

5 MAY

- 本所張彬所長5月11日前往蓮華池研究中心進行主任布達、勉勵及視察相關業務。
- 本所臺北植物園與屏東科技大學植物標本館合作推出「臺灣藤蔓植物特展」，因應新冠肺炎防疫，於5月18日(518博物館日)與中央研究院數位文化中心開放博物館合作推出線上特展。
- 本所與臺灣猛禽研究會合作進行「臺北植物園鳳頭蒼鷹育雛階段巢位攝影暨直播案」，自5月27日開播至7月8日收播，於臉書　林試所—幸福森活　粉絲專頁完成7篇貼文，統計截至7月3日累積37,249次互動次數，518次貼文分享，提高民眾對都市指標物種繁殖史與都市林生態功能的瞭解。

6 JUNE

- 本所木材纖維組何振隆研究員兼組長、徐健國助理研究員於6月1日接受環境資訊中心特約記者廖靜蕙小姐專訪「廢物防疫順時中，農林廢料再製成紙香皂，臺灣杉、馬告精油抗菌留香」，介紹利用農林廢料所萃取的精油，開發出紙溶於手的精油抗菌紙香皂。
- 本所木材纖維組何振隆研究員兼組長、徐健國助理研究員、徐光平聘用助理研究員於6月2日接受國立教育廣播電臺蕭曼屏小姐專訪「農林廢料再利用—環保愛物又防疫」，介紹林業試驗所之研究重點、農林廢料之循環經濟利用及近年來的研發成果。
- 本所6月5日參與於國立中興大學舉辦的「2020中華林產事業協會學術論文暨研究成果研討會」並進行循環資材高值化利用之成果展示發表。
- 本所六龜研究中心於6月13日舉辦扇平生態教育志工第二季專業訓練。
- 本所與聯合報系願景工程6月13日假中和四號公園(八二三紀念公園)合作辦理「幫地球降溫—牽手種樹嘉年華」活動。
- 本所6月16日與國立臺灣大學森林環境暨資源學系及臺灣都市林健康美化協會，共同舉辦「2020都市樹木健康檢查與風險管理論壇」，共計80人次參加；會中邀請國內產、官、學專家共襄盛舉，見證我國國人同胞及研究專家們在樹木保護議題上的熱忱。
- 太麻里研究中心6月17日及19日，在臺東縣弱勢者關懷協會太麻里館辦理食農教育課程，除了講解食農教育的重要性之外，現場並DIY自製活化糙米，參加的鄉親十分踴躍。
- 本所森林經營組6月18日於臺北植物園舉辦「雷達掃描與森林空間資訊處理技術研習會」，邀請臺灣儀器行資深應用主任及應用工程師解說光達設備於林業研究領域之技術與發展，並分享戶外實拍經驗。

7 JULY

- 本所以「傳承臺灣植物研究史」為核心，完成臺北植物園腊葉館(原為日治時期臺灣總督府「中央研究所林業部腊葉館」)修復與再利用，獲臺北市文化資產保存肯定，於7月9日獲頒「第一屆臺北市文化資產保存維護譽揚獎」殊榮。
- 張彬所長率領韌性都市林團隊於7月10日與國立臺灣圖書館、新北市中和區公所共同簽署合作交流備忘錄，將透過三方共同推動，建構中和四號公園為全國首座韌性都市林。
- 所森林經營組7月10日至8月30日於臺北植物園腊葉館二樓舉辦「森林×現代性—航遙測影像下的科學敘事」特展，展示航遙測技術之進程及科學敘事之成果，配合特展同時辦理4場專題講座。
- 本所主辦109年度農業創新育成中心法人標竿學習活動，於7月15日透過參訪工業技術研究院，學習瞭解工研院技轉及育成中心之運作模式。
- 本所蓮華池研究中心於7月20日舉辦第1季志工生態研習暨員工環境教育課程，邀請關渡自然公園葉再富主任和臺灣大學生物資源暨農學院實驗林管理處楊智凱博士授課。
- 本所109年度「試驗林示範經營計畫」期中業務考察暨111年度預定案審查會議，7月27日至29日於臺北及宜蘭等地舉行。會議中各研究中心針對試驗林的經營分別提出長程目標與短程目標，並向委員簡報未來的各項規劃與願景。

8 AUG

- 本所於8月5日辦理「COVID未來式，報你知~天然防疫，森(身)心療癒」記者會，以本所三大研發成果提出「防疫三撇步」，提供民眾防疫利器，協助民眾實踐天然防疫，達到森(身)心療癒。
- 本所太麻里研究中心8月6日在金峰鄉嘉蘭社區舉辦「臺灣杉疏伐作業說明會」，這是本所首次在臺東地區辦理的疏伐作業說明會，以消彌政府與民眾間對於疏伐作業的疑慮，當地居民在參與後也普遍表示支持。
- 本所8月11日於農委會5樓大禮堂舉辦農業創新育成中心聯合畢業成果發表會，展現育成中心服務能量及廠商輔導成果。
- 本所8月24日辦理「雙館齊下，守護臺灣生物標本寶藏」記者會，發表本所昆蟲標本館與植物標本館最新成果，未來將攜手中研院生物多樣性研究中心標本館、臺灣大學植物與昆蟲標本館合體出擊，保護前人累積的珍貴標本與資訊寶藏，一起為臺灣未來的研究發展奠定堅實基礎。
- 本所於8月25日與行政院國軍退除役官兵輔導委員會彰化農場簽署合作備忘錄，雙方正式成為合作夥伴。

- 本所六龜研究中心於8月25日至26日，在退輔會高雄農場舉辦農遊元素特色化及優化講座工作坊，邀集在地休閒農業區及農場經營者、導遊領隊、社區營造工作者等相關人員共20位參與，透過生態探索活動與生物資源評量的方式，為參與者提供不同以往的方向與思維。

- 本所蓮華池研究中心於8月26日舉辦第2季志工生態研習暨員工環境教育課程，邀請特有生物研究保育中心林子超先生和屏東野鳥協會吳正文先生授課。

- 本所參與財政部8月30日在墾丁國家森林遊樂區(恆春熱帶植物園)辦理之「財政部109年統一發票盃路跑活動」屏東場，於現場設有攤位，民眾可透過捐贈發票並參與攤位活動或遊戲獲得由本所恆春研究中心提供的免費樹苗。

9 SEP

- 本所蓮華池研究中心於9月2日辦理「109年度林園療癒嚮導培訓課程結訓典禮」。

- 本所於9月10日至11日邀請所內外專家成立實地查核專案小組，進行農業科技計畫現地查核。

- 本所9月10日及14日於行政大樓4樓會議室舉行「資通安全通識教育訓練」，邀請「萬弘資訊顧問有限公司」楊宸豪資安顧問前來擔任講師。

- 本所技術服務組9月11日於本所行政大樓四樓會議室辦理「著作權法專題講座」，邀請東吳大學科技暨智慧財產權法研究中心章忠信主任前來講述著作權基本概論及常見的著作權相關議題。

- 本所與新中和社區大學合作，9月11日開始於國立臺灣圖書館內教室辦理一系列「韌性都市林志工隊」2020年秋季班培訓課程，由本所相關領域研究人員及外聘講師，為學員介紹韌性都市林的各專業領域知識，總計培訓志工隊種子學員38名。

- 本所育林組於9月17日至18日假行政大樓4樓會議室舉辦「2020森林資源保存與利用研討會」。

- 本所木材纖維組與森林利用組於9月19日與國立臺灣大學合辦「2020 Kiss Science—科學開門，青春不悶活動」，以現場海報、實物展示及導覽解說展現「以本土永續生質資材開發新型包裝材料提升國產蔬果保鮮能力」計畫之相關成果，活動參與者以高中生及教師為主。

- 本所蓮華池研究中心於9月19日至20日及26日至27日，參加中興大學惠蓀林場舉辦之「2020惠蓀林場木文化《原森寶藏》」活動，以蓮華池研究中心執行之國家型方舟計畫、林園療癒和林下經濟為主題，展示相關研究成果。

- 本所「臺灣藤蔓植物特展」實體展於9月20日在臺北植物園腊葉館正式開展，展出時間至11月29日止。

- 本所中埔研究中心鄧書麟副研究員兼主任，9月20日至22日受邀協助科技部科普計畫—「發現國境之南—從南島看臺灣生物多樣性」紀錄片拍攝，針對香蕉灣生態保護區與蘭嶼地區棋盤腳的族群變異進行相關研究之介紹。

- 本所技術服務組於9月24日及25日在花蓮馬太鞍休閒農業區舉辦「生態永續農業旅遊講座暨工作坊」，讓休閒農業經營者了解生態資源調查技術的方法，創造具生態特色的體驗服務，並由木材纖維組示範按摩舒壓精油調配手作課程及利用回收植物性纖維資材，進行手抄紙抄製及流沙箋製作體驗課程。

- 本所於9月24日至26日於世貿一館舉辦「2020臺灣創新技術博覽會」展示本所「高強度竹漿連史紙抄製技術」之研發成果。

- 本所蓮華池研究中心與國立自然科學博物館、臺中市大同扶輪社於9月27日特舉辦新住民「快樂新學堂」—親愛自然・生態體驗活動，帶領新住民家庭親子進行戶外生態參訪，共有新住民家庭共36人參與。

10 OCT

- 為開發多功能木材收穫機之效用，本所森林經營組10月與永在林業合作社簽署合作備忘錄，合作實機現地應用與訓練，期能培育公、私部門林業機械化的人才，增進森林收穫效率及品質。

- 本所太麻里研究中心及森林保護組於10月6日舉辦真菌講習班，藉由實體觀察野外大型真菌讓學員增進相關知識。

- 本所集水區經營組10月14日假本所行政大樓4樓會議室辦理「2020森林集水區及環境監測研討會」。

- 本所於10月20日至12月25日於技術服務大樓1樓紙張樣品陳列室舉辦「紙繡風華—格拉辛紙再次遇見紙繡特展」，介紹特種紙中的格拉辛紙，並與中華紙繡協會合作，利用紙繡的技藝表現出格拉辛紙的特性。

- 本所太麻里研究中心胡元瑋主任於10月21日接受國立教育電臺臺東分臺專訪，介紹太麻里研究中心主要業務及重點工作，並講述臺東地區樹木病蟲害實例與本所「林木疫情鑑定與資訊中心」運作情形。

- 本所蓮華池研究中心10月23日舉辦第3季志工生態研習暨員工環境教育課程，邀請臺灣大學生物資源暨農學院實驗林管理處楊智凱博士和羅娜社區發展協會向志堅先生授課。

- 本所植物園組規劃拍攝紀錄各研究中心及轄下植物園所執行的國家植物園方舟計畫，導演及企劃團隊於10月23日抵達中埔研究中心，參觀埤子頭植物園、嘉義樹木園及四湖海岸植物園，並由鄧書麟主任向拍攝團隊進行導覽解說。

- 本所技術服務組10月26日在總所行政大樓4樓會議室及各研究中心會議室辦理國發會開放文件格式推廣及宣導說明會線上直播之觀看，以擴大ODF政策於所內推廣及應用的效果。

- 本所福山研究中心10月27日舉辦「林業試驗所福山研究中心30週年慶暨回顧與展望座談會」，邀請本所歷任所長、福山主任(分所長)及規劃籌備期間有功之人員與退休老員工，共同研討研究中心未來發展願景。

- 本所六龜研究中心10月30日與林務局屏東林區管理處於六龜試驗林舉辦「臺灣杉人工林中層疏伐規劃技術交流」，強化雙方對於疏伐作業之技術。

11 NOV

- 本所六龜研究中心與華江溼地守護聯盟11月1日至3日假扇平森林科學園舉辦三天兩夜的參訪研習。

- 本所於11月3日參與行政院農業委員會所舉辦之「循環農業環島列車活動成果露出之返航記者會」，並於11月4日至5日參與於南港展覽館舉辦之「2020 The Practice and Benefits of Circular Agriculture in Waste Reducing and Recycling循環農業國際研討會暨成果發表會」及「亞太農業技術展」，進行林業循環加值利用模式與創新技術計畫之成果發表及海報展示。

- 本所11月5日與臺灣大學生農學院植物教學醫院及臺灣植物及樹木醫學學會，共同舉辦「2020植，栽及樹木之健檢與醫療研討會」，會中邀請國內產、官、學界的專家，就國人所關注的樹木健康議題進行討論，讓與會的民眾充分了解國內對樹木保護工作推動的決心與努力。

- 本所蓮華池研究中心11月7日及9日辦理特有生物研究保育中心志工團林園療癒移地訓練課程，本次活動2梯次共計99人參加。

- 本所張彬所長及中埔研究中心團隊11月9日與林務局南投林區管理處李政賢處長於四湖海岸工作站進行現場勘查與聯繫，共同討論移除外來種埃及聖鷺之防治成效及後勤協助支援等議題，透過更緊密的夥伴關係，加強防治之行動進行。

- 為提倡環境林研究及提供技術交流平臺，本所中埔研究中心於11月19日舉辦「第15屆環境保護林經營管理研討會」，期望透過不同領域意見的互動，能有效改善或降低目前臺灣地區日益惡化的生態環境。

- 本所技術服務組為辦理109 年農遊元素特色化及優化計畫，於11月20日召開全臺休閒農場及休閒農業區示範場域徵選第一次評選會議，並於12月1日至3日、15日、21日至23日進行入選場域現地勘查，12月28日舉辦第二次評選會議，決議獲選的四個場域將自110年度開始進行輔導。

- 本所張彬所長11月22日至24日及11月29日至12月1日率研究團隊分赴金門與馬祖進行島嶼生態系及珍稀動植物棲地訪查，考察期間與金門林務所及馬祖產業發展處就小島林業經營實務進行深度討論，共同研商離島特殊物種保育策略並評估產業化之可行性。

- 本所六龜研究中心11月22日辦理扇平志工第四季研習暨中埔研究中心參訪活動，課程由中埔研究中心蔡景株助理研究員分享「樹木外部形態辨識與實務」，並帶領志工夥伴導覽埤子頭植物園與嘉義樹木園植物特色，活動內容相當精采。

- 11月23日實踐大學休閒產業管理學系王雅亮副教授帶領18位環境教育學程學員，蒞臨六龜研究中心所屬扇平森林生態科學園，進行環教場域參訪學習。

- 本所與原住民族委員會11月24日於森林研究大樓國際會議廳舉辦「2020植物原物料高峰會暨媒合會」。

- 本所太麻里研究中心及保護組於11月25日舉辦褐根病防治講習，為臺東市三角公園老榕樹進行防治作業，由森林保護組傅春旭研究員擔任現場講師。

- 本所「國家植物園方舟計畫」獲行政院農業委員會推薦參選「國家永續發展獎選拔表揚計畫」，經永續會初評及臺北植物園現地複評，榮獲政府機關類入選獎，並於11月25日獲行政院蘇貞昌院長頒獎表揚。

- 本所森林經營組11月26日於行政大樓4樓會議室辦理「2020平地造林試驗及監測研討會」，闡述平地造林試驗監測計畫成效與轉向，分享以平森園區為活動場域，有關林園療育、風景營造、生態廊道、混農林規劃、速生樹種培育、疏伐對生物多樣性影響等研究成果。

- 本所11月27日至110年1月31日於技術服務大樓1樓紙張樣品陳列室舉辦「紙短情長 療育樂齡—指繪幸福粉彩畫展」，本次展覽利用國產的竹資材解纖抄製紙張，並透過粉彩畫的技巧，結合樂齡長者們的創意與觀察力創作許多美麗的作品。

- 本所與國立臺灣圖書館、新北市中和區公所，以及新中和社區大學於11月28日共同辦理「韌性都市林示範區灌叢生態化活動」。由新中和社區大學韌性都市林志工隊種植原生灌木及草本植物，豐富都市林的結構，總計為中和四號公園新添19種、316株植物，為該環境增加生物多樣性、提升生態及社會韌性。

- 本所11月29日於虎頭埤風景區辦理農業創新育成中心聯合展售會，以加速育成，快活樂農為主題，協助育成中心廠商增加商品及品牌曝光率。

12 DEC

- 12月1日至2日國際森林管理委員會(FSC)驗證公司派員至本所蓮華池研究中心進行年度稽核作業，本所蓮華池研究中心符合並通過109年國際森林認證年度審查作業。

- 本所六龜研究中心於12月1日至2日，與林務局嘉義林區管理處於六龜試驗林舉辦「臺灣杉人工林中層疏伐與臺灣山茶育苗作業技術交流會議」，由六龜研究中心陳永修主任及嘉義林區管理處張岱處長帶領研究與工作人員共同討論交流林業技術。

- 本所太麻里研究中心胡元瑋主任於12月2日接受客家電視臺專訪，說明樹木保護條例內容及列管老樹標準，並介紹本所林木疫情中心的主要任務及貢獻。

- 本所於12月3日至6日於南港展覽館之「2020臺灣醫療科技展—農業健康館」展示本所「香氛抗菌特種紙」之研發成果。
- 本所蓮華池研究中心於12月8日舉辦第4季志工生態研習暨員工環境教育課程，邀請國立中興大學蔣慎思教授和本所福山研究中心林建融助理研究員授課。
- 本所受交通部公路總局委託辦理之「臺九線金崙高架橋下保安林復育案」於109年底結案，並於12月9至10日進行本案會計查核、成果檢討暨結案程序研商會議，邀請各相關單位進行現地勘查及討論。
- 本所蓮華池研究中心於12月11日至12日舉辦北部濕地志工移地生態研習活動，參訪臺北市關渡自然公園與新北市濕地故事館所轄二個區塊之濕地。
- 本所森林經營組12月22日至110年2月17日於高雄科學工藝博物館舉辦「森林×現代性—航遙測影像下的科學敘事」特展，展示高雄地區多幅早期美軍拍攝的航空照片，配合特展同時辦理4場專題講座。
- 本所技術服務組辦理「109年農遊元素特色化及優化」一案，進行全臺標的場域的評選， 12月22日由技服組劉一新組長與同行委員至中埔研究中心轄下四湖海岸植物園進行交流，其中李桃生委員亦將本次輔導生態示範場域之經驗與中埔團隊分享。
- 12月27日本所指導韌性都市林志工隊學員參加「第八屆生態雙和嘉年華」活動，藉由擺攤互動遊戲及四號公園導覽解說，將本所韌性都市林試驗的理念及成果與韌性都市林示範區中和四號公園的周邊居民分享，深獲居民迴響，帶動居民參與四號公園韌性都市林試驗計畫的意願。

Major events

JANUARY–DECEMBER 2020

JANUARY

- On January 5, the Hengchun Research Center of the Taiwan Forestry Research Institute (TFRI) held its annual volunteer workshop meeting in the Pingtung Agricultural Biotechnology Park, Council of Agriculture, Executive Yuan, seeing a total of 45 participants including volunteers and the center's staff.

- From January 6 to 8, the TFRI's Technical Service Division conducted a three-day long end-of-project survey and review meeting for the Experimental Forest Demonstration Project at the Taimalee Research Center and Lioukuei Research Center.

- From January 13 to 14, the TFRI's Forest Management Division held the Human-Machine Competitive Climbing Observation and Exchange Workshop at the Fushan Research Center. The workshop invited professional tree-climbing teams to share their expertise and talk about the equipment they use. In addition, the tree-climbing machine development team from National Taiwan University's Department of Mechanical Engineering showcased their tree-climbing robot. Both teams discussed the difference in techniques employed by humans and machines in the tree climbing process and explored possible technological advancements of tree-climbing robots.

- On January 15, the TFRI's Lioukuei Research Center held the first 2020 TFRI Staff Meeting with Director Chen Yung-Hsiu as the moderator. The meeting went over the TFRI's completed projects during 2019 and future projects for 2020, and introduced the new staff members.

- The TFRI's Lioukuei Research Center Director Chen Yung-Hsiu proposed using unused spaces in the center to establish a woodworking classroom to promote the value of domestic wood and bamboo materials, and to increase the scope of forest ecology education offered by the center. Since January 31, 2020, a total of 7 classes have been held to train volunteer woodworking seed teachers.

FEBRUARY

- From February 8 to 9, the TFRI's Lioukuei Research Center held the first Shanping Ecology Education Volunteer training event of the year.

- On February 10, the TFRI's Technical Service Division held a learning seminar for Morpho, an EML editor, in the meeting room on the fourth floor of the TFRI's Administration Building.

- From February 10 to 14, and February 24 to 26, the TFRI's Silviculture Division and Lioukuei Research Center assembled a research team and conducted growth surveys for Forest Compartments 20 and 24 in the Dona area in Kaohsiung. On February 13, TFRI Director General Chang Bin and Division Director You Han-Ming, accompanied by Lioukuei Research Center Director Chen Yung-Hsiu, visited Forest Compartment 24 to examine the growth survey and seed selection process of Taiwania cryptomerioides.

- On February 14, the TFRI's Technical Service Division held an IT safety and risk management education and training event in the meeting room on the fourth floor of the TFRI's administration building.

- On February 25, the TFRI's Technical Service Division invited Dr. Yang Szu-Yuan, Division Director at the Industrial Technology Research Institute, to give a speech on the strategies and mechanisms of technology transfer to help staff members better understand the concept of technology transfer.

MARCH

- On March 3, Director General Chang Bin led a team primarily composed of staff from the Forest Management Division of the Taiwan Agricultural Research Institute to assist with their hazardous tree inspection. Inspection results revealed that while none of the trees are currently in danger of falling, pests and other diseases must still be carefully monitored to ensure public safety.

- On March 7, the TFRI's Taimalee Research Center attended a Taitung County tree planting, tree conservation, and forest market event jointly held by the Forestry Bureau Taitung Forest District Office and Taitung County Government. The Center presented an exhibition that was titled “Moth, Beetle, and Plant Specimen Display in the Taimalee Region.” In addition, the director led a team of staff to explain to the public general ecological knowledge related to the theme of the exhibition.

- On March 19, the Technical Service Division worked with a third-party authenticator to conduct a two-day long IT system safety verification review. This is the third year that the Center has undergone this verification review, which focuses on IT safety validation on the organizational, management, and execution levels, and on the computer room.

- On March 22, the TFRI's Chungpu Research Center participated in the 2020 Minxiong Township Fule Park Tree Planting Event held by the Chiayi County Government. The event focused green cultivation and management, and was conducted alongside the promotion of forestry technology, attracting over 250 visitors.

- From March 23 to 24, the TFRI's Fushan Research Center held a training course on tree pruning at the Fushan Botanical Garden. The Center invited Mr. Lee Pi-Feng, a certified arborist of the Japanese Cultural Association and the current Secretary-General of the Taiwan Arboriculture Society, to conduct theoretical and practical training for the supervisors and personnel related to the management of the forestry laboratory's botanical garden. A total of 32 people participated in this training.

APRIL

- On April 1, the TFRI's Taimalee Research Center started assisting the Chia-Lan Community Development Center of Jinfeng Township in Taitung County with the implementation of the 2020 Buliblosan Tribe Forest Patrol Project from the Taitung Forest District Office of the Forestry Bureau. The Center provided lecturers and assisted the forestry patrol work.

- From April 11 to 12, the Yunlin County Government worked with the Yunlin County Gukeng Township Office to hold a Tung Blossom Festival at Hebaoshantonghua Park. TFRI's Chungpu Research Center was invited to attend to conduct promotional activities regarding forestry technology.

- On April 15, Director General Chang Bin led the resilient urban forest team to plant 12 native Taiwan tree species in the 2020 Resilient Urban Forest Demonstration Site within the 823 Memorial Park in New Taipei City as part of an effort to gradually build a multi-layered urban forest that enhances the resilience of the surrounding area.

- On April 15 and 22, the TFRI's Agricultural Innovation Incubation Center invited Dr. Chiu Hung-Chiang, consultant at the Youth Career Development Association Headquarters, to conduct an Incubator Case Counseling and Diagnostic Consultation in the conference room on the first floor of the Heping Office Building to enhance the depth and breadth of counseling for incubatees.

- On April 19, about 50 students and teachers from Sihu Elementary School in Sihu Township, Yunlin County, rode bicycles to the Sihu Coastal Botanical Garden for the sixth-grade students' 2020 Iron Horse Little Warriors event. The TFRI's Chungpu Research Center assigned Assistant Researcher Tsai Ching-Chu as their tour guide for the event to give the class a unique graduation trip.

- On April 21, the TFRI attended the "Kenting National Park Formosan Sika Deer Population Restoration Management Team Meeting" held by the Forestry Bureau, Council of Agriculture, Executive Yuan at the Kenting National Park Headquarters. The meeting discussed "establishing indicators for assessing the implementation progress of the population restoration project, as well as general management directives." The meeting also went over methods to deal with the damages caused by Formosan sika deer in the Kenting Uplifted Coral Reef Nature Reserve, which is managed by the TFRI.

- From April 22 to May 10, the TFRI collaborated with the Hsinchu Forest District Office, Forestry Bureau, Council of Agriculture, Executive Yuan, Hoh Market, and the Wutong Foundation to hold the "Food x Forest - Colony Special Exhibition" to introduce forest food, forest art, sensory healing, forest harvesting, and forest seeds to the public.

MAY

- On May 11, TFRI Director General Chang Bin visited the Lienhuachih Research Center to attend the inauguration ceremony of the new director, as well as to inspect the Center's overall operational status and commend the staff.

- On May 18 (International Museum Day), the "Taiwan Vine Plant Exhibition" collaboratively produced by TFRI's Taipei Botanical Garden and the National Pingtung University of Science and Technology Herbarium was unveiled to the public. To better accommodate COVID-19 epidemic prevention and control measures, the exhibition also worked with the Academia Sinica Center for Digital Cultures to launch a digital open museum alongside the physical exhibition.

- From May 27 to July 8, the TFRI worked with the Raptor Research Group of Taiwan to produce the "Accipiter trivirgatus Hatchling Nest Photography and Live Streaming Event." The event was aired on the TFRI Facebook fan page alongside seven posts throughout the project's duration. As of July 3, the page attracted 37,249 visitors and 518 shares, raising public awareness of the reproduction process of important indicators species, as well as the ecosystem function of the urban forest.

JUNE

- On June 1, Division Director and Researcher Ho Chen-Lung and Assistant Researcher Shei Chein-Kuo from the TFRI's Wood Cellulose Division were interviewed by Ms. Liao Ching-Hui from the Taiwan Environmental Information Center on "the use of agricultural and forestry waste to produce antibacterial essential oils and paper soaps to help with epidemic prevention." The interview introduced to the public antibacterial paper soap that dissolves in the hand after use and aromatic Taiwania cryptomerioides/ Litsea cubeba antibacterial essential oil derived from forestry and agricultural waste.

- On June 2, Division Director and Researcher Ho Chen-Lung, Assistant Researcher Shei Chein-Kuo, and Assistant Researcher Hsu Kuang-Ping from TFRI's Wood Cellulose Division were interviewed by Ms. Hsiao Man-Ping from the National Education Radio on "Recycling of Agricultural and Forestry Waste - Environmental Protection and Epidemic Prevention." The interview introduced the research focus of the TFRI and its R&D results on the recycling and economic utilization of agricultural and forestry waste in recent years.

- On June 5, the TFRI attended the "2020 China Forest Products Association Academic Paper and Research Seminar" held at National Chung Hsing University, wherein the Institute presented its research results on the high value utilization of recycled materials.

- On June 13, the TFRI's Lioukuei Research Center held the second Shanping Ecology Education Volunteer training event of the year.

- On June 13, the TFRI worked with UDN Vision to hold the "Help Cool the Earth - Hand in Hand Tree Planting Carnival" at the 823 Memorial Park in New Taipei City.

- On June 16, the TFRI attended the "2020 Urban Tree Health Inspection and Risk Management Forum" together with the Department of Forestry and Resource Conservation, National Taiwan University and the Taiwan Arboriculture Society. The Forum had a total of 80 participants and invited experts and scholars from the private, government, and academic circles, serving as a testament to the passionate devotion of our peers and research experts over tree protection issues.

- From June 17 to 19, TFRI's Taimalee Research Center held a food and agriculture association class at the Taimalee Division Building of the Taitung Concern Association for Disadvantaged Groups. The class raised public awareness on the importance of food and agriculture education and invited participants to produce DIY activated brown rice, which turned out to be a very popular activity.

- On June 18, TFRI's Forest Management Division held the "Radar Scanning and Forest Spatial Information Processing Technology Workshop." The Division invited senior application directors and experienced application engineers from Taiwan Instrument Co. to explain the technology and development of radar equipment in the field of forestry research, and to share their experience in outdoor photography.

JULY

- Inheriting the history of plant research in Taiwan, the TFRI completed the renovation of the Taipei Botanical Garden's Herbarium (the former 'Herbarium of the Forestry Division of the Central Research Institute' during the Japanese occupation of Taiwan). For this merit, the Institute received the "First Taipei City Culture Heritage Conservation Award" on July 9.

- On July 10, Director General Chang Bin led the resilient urban forest team to sign a memorandum of understanding (MOU) with the National Taiwan Library and the New Taipei City Zhonghe District Office to collaboratively transform the 823 Memorial Park into the first resilient urban forest in Taiwan.

- From July 10 to August 30, TFRI's Forest Management Division held the "Forests x Modernity - Scientific Narratives from Aerial Remote Sensing Images Exhibition" at the second floor of the Herbarium of Taipei Botanical Garden. The exhibition showcased the development of aerial remote sensing technology and the possibilities of scientific narratives. In addition, it was held alongside four special lectures.

- On July 15, 2020, the Agricultural Innovation Incubation Center held a milestone learning activity, wherein it visited the Industrial Technology Research Institute (ITRI) to learn the operation mode of its Technology Transfer and Incubation Center.

- On July 20, the TFRI's Lienhuachih Research Center held its first quarterly volunteer ecology study and staff environmental education course. For this occasion, the Center invited Guandu Nature Park Director Yeh Tsai-Fu and Dr. Yang Chih-Kai from the Experimental Forest Office, College of Bio-Resources and Agriculture, National Taiwan University as guest lecturers.

- From July 27 to 29, the TFRI conducted its mid-term review of the 2020 "Experimental Forest Demonstration Site Project" and the 2022 Proposed Project Preview Meeting in Taipei and Yilan. During the meeting, each research center proposed its long-term and short-term goals for the management of the experimental forests and briefed the council members on their future plans.

AUGUST

- On August 5, the TFRI held a press conference titled "The Future of COVID: Using the Power of Nature and the Forest to Heal and Prevent Diseases." The conference proposed three epidemic prevention tips based on three important research results from the Institute to provide the public with more epidemic prevention tools that can help them practice natural epidemic prevention and achieve healing of the body and soul.

- On August 6, TFRI's Taimalee Research Center held a "Taiwania Thinning Informational Meeting" in the Chia-Lan community of Jinfeng Township. The meeting was the first public-oriented informational meeting on the topic of forestry thinning. It sought to address concerns of the local government and the public regarding thinning operations. Most residents expressed support of the forest thinning process after attending the meeting.

- On August 11, TFRI's Agricultural Innovation Incubation Center held a results exhibition ceremony in the auditorium on the fifth floor of the Council of Agriculture Building, showcasing the commercial results of the Center and the possibilities of its incubation services.

- On August 24, the TFRI held the "Twin Museums' Taiwan's Biological Specimen Press Conference," where it announced the latest results of its herbarium and entomology specimen museum. In the future, the Institute will work with Academia Sinica's Biodiversity Research Center and National Taiwan University Insect Museum and Plant Museum to preserve the precious specimens and information gathered by historic scholars to lay a solid foundation for future research development in Taiwan.

- On August 25, the TFRI signed an MOU with the Changhua Veterans Affairs Council Farm, Executive Yuan establishing official collaborative status.

- From August 25 to 26, the TFRI's Lioukuei Research Center held a workshop for the Farm Tourism Specialization and Optimization Project at the Kaohsiung Veterans Affair Council Farm. A total of 20 participants were invited to participate in the workshop, including operators of local leisure agriculture businesses and farms, tour guides, community leaders, and other related personnel. The workshop encouraged participants to come up with different directions and ideas using ecological exploration and biological resource assessment.

- On August 26, the TFRI's Lienhuachih Research Center held its second quarterly volunteer ecology study and staff environmental education course. The Center invited Dr. Lin Tzu-Chao from the Endemic Species Research Institute and Mr. Wu Cheng-Wen from the Pingtung Wild Bird Association as guest lecturers.

- On August 30, the TFRI's Hengchun Research Center set up a booth at the "2020 Ministry of Finance Uniform-Invoice Cup—Road Race Pingtung" held at the Kenting National Forest Recreation Area (Hengchun Tropical Botanic Garden). The public could donate uniform invoices to the booth to participate in events or games and win free saplings as prizes.

SEPTEMBER

- On September 2, the TFRI's Lienhuachih Research Center held the "2020 Forest Garden Healing Instructor Training Course Completion Ceremony."

- From September 10 to 11, the TFRI invited experts from both inside and outside the Institute to set up an on-site inspection team to conduct field inspections of various agricultural technology projects.

- From September 10 to 14, the TFRI held an "Information Security General Education Training Event" in the meeting room on the fourth floor of the Administration Building. The Institute invited IT security consultant Mr. Yang Chen-Hao from Wanhung Information Consulting as the guest speaker.

- On September 11, TFRI started a series of training courses for the Fall 2020 class of the Resilient Urban Forestry Volunteer Team at the National Taiwan Library in collaboration with New Zhonghe Community College. A total of 38 seed volunteers were trained by Institute researchers and external lecturers, introducing the participants to various fields of expertise in the field of resilient urban forestry.

- From September 17 to 18, TFRI's Silviculture Division held the "2020 Forest Resource Conservation and Utilization Seminar" in the meeting room on the fourth floor of the Administration Building.

- On September 19, TFRI's Wood Cellulose Division and Forest Utilization Division held the "2020 Kiss Science—Let Science Open the Door to Your Youth Event" in collaboration with National Taiwan University. In this event, the Institute presented the results of the "Developing New Packaging Materials with Sustainable and Local Biomaterials to Enhance the Freshness of Domestic Fruits and Vegetables Research Project" through various posters, exhibitions, and guided tours to an audience comprised mainly of high school students and teachers.

- From September 19 to 20 and 26 to 27, the TFRI's Lienhuachih Research Center participated in the "2020 Huisun Forest Culture 'Native Treasure' Event" held by National Chung Hsing University at the Huisun Forest Area. The Center exhibited its implementation results of various national-level ark projects, forest healing, and forest economy-related themes.

- On September 20, TFRI's the physical "Taiwan Vine Plant Exhibition" officially debuted at the Herbarium of Taipei Botanical Garden, and lasted until November 29.

- From September 20 to 22, Dr. Deng Shu-Lin, Associate Researcher and Director of TFRI's Chungpu Research Center, was invited to assist in the filming of the Ministry of Science and Technology's science film project, "Discovering the South - Taiwan's Biodiversity from an Austronesian Perspective." He talked about research into the mutations among Barringtonia asiatica populations located in the Orchid Island and Banana Bay Ecological Reserve.

- From September 24 to 25, TFRI's Technical Service Division held the "Sustainable Agriculture and Tourism Seminar and Workshops" in the Matai'an Recreation Agriculture Zone in Hualien County, helping tourism businesses understand ecological resource survey techniques to create unique experiences for guests with an ecological flare. The Wood Cellulose Division also presented a course on manually concocting massage oil and a course on manual fine paper/marbled paper crafting using recycled plant fiber materials.

- From September 24 to 26, the TFRI attended the "2020 Taiwan Innotech Expo" held at the Taipei World Trade Center to showcase its research and progress in the manufacturing of high-strength bamboo pulp fine paper.

- On September 27, the TFRI's Lienhuachih Research Center came together with the National Museum of Natural Science and the Rotary Club of Taichung Tatong to hold the "Learning for Fun: Loving and Experiencing Nature" event for Taiwanese new immigrants. A total of 36 people from new immigrant families participated in the outdoor ecological tour.

OCTOBER

- In October, the TFRI's Forest Management Division signed an MOU with Yongzai Forestry for the development of a multifunctional wood harvesting machine. The partnership aims to increase forest harvest efficiency and quality by improving the field applicability and training resources for wood harvesting machines, contributing to mechanized forestry in the public and private sectors.

- On October 6, the TFRI's Taimalee Research Center and Forest Protection Division held a macrofungal workshop, where students had the opportunity to observe wild macrofungal outdoors and to learn about them.

- On October 14, TFRI's Watershed Management Division held the "2020 Forest Watershed Area and Surrounding Environment Monitoring Seminar" in the meeting room on the fourth floor of the Administration Building.

- From October 20 to December 25, the TFRI held a special exhibition titled "Paper Embroidery - Glassine Paper x Embroidery" in the sample paper exhibition room on the first floor of the Technical Service Building. The exhibition aimed to introduce the public to glassine paper. In addition, by working with the China Paper Embroidery Association, the Institute demonstrated the characteristics of glassine paper through various embroidery patterns.

- On October 21, Director Hu Yuan-Wei from TFRI's Taimalee Research Center was interviewed by the Taitung Substation, National Education Radio Station. During the interview, he introduced the primary tasks and focuses of the Taimalee Research Center. The interview raised public awareness on actual cases of tree diseases and pests in the eastern part of Taiwan and the operation of the "Forest Epidemic Identification and Information Center" of the Institute.

- On October 23, the TFRI's Lienhuachih Research Center held its third quarterly volunteer ecology study and staff environmental education course. The Center invited Dr. Yang Chih-Kai from the Experimental Forest Office, College of Bio-Resources and Agriculture, National Taiwan University and Mr. Hsiang Chih-Chien from the Luna Community Center Development Association as guest lecturers.

- On October 23, the TFRI's Botanical Garden Division commenced the Division's film project to record the progress of the National Botanical Garden project. The crew and director arrived at the Chungpu Research Center and were given a tour by Center Director Deng Shu-Lin visiting Bizihtou Botanical Garden, Chiayi Botanical Garden, and Sihu Coastal Botanical Garden.

- On October 26, TFRI's Technical Service Division held a promotion webinar for open document format (ODF) tools developed by the National Development Council to encourage broader implementation of ODF within the Institute. The webinar was simultaneously streamed in the meeting room on the fourth floor of the Administration Building and in meeting rooms at each branch research center.

- On October 27, the TFRI's Fushan Research Center held the "TFRI Fushan Research Center 30th Anniversary Retrospective and Future Vision Seminar." The Center invited former directors, retired staff, the current director, and current staff responsible for hosting the Seminar to share their thoughts on the Center's future.

- On October 30, the TFRI's Lioukuei Research Center worked with the Forestry Bureau's Pingtung Forest District Office to hold the "Taiwania Man-made Intermediate Forest Thinning Technique Discussion Forum" at Liugui Experimental Forest to enhance the technical knowledge on thinning designs for both parties.

NOVEMBER

- From November 1 to 3, TFRI's Lioukuei Research Center held a three-day long education tour event at the Shanping Forest Ecological Garden in collaboration with the Huachiang Wetland Guardian Alliance.

- On November 3, the TFRI attended the "Taiwan Circular Agriculture Results Exhibition Press Conference" held by the Council of Agriculture, Executive Yuan. On November 4 to 5, the TFRI attended "The 2020 Practice and Benefits of Circular Agriculture in Waste Reducing and Recycling Conference," and the "Asia Agri-Tech Expo & Forum" held in the Nangang Exhibition Center, where it exhibited its R&D results on innovative technology in the circular value-added forestry model with poster exhibitions.

- On November 5, the TFRI joined hands with the Plant Teaching Hospital, National Taiwan University and the Plant and Tree Medicine Society of Taiwan to hold the "2020 Potted Plants and Tree Health Inspection and Medical Seminar," inviting experts from the business, government, and academia to discuss tree health issues that are of the concern to the public, and raising awareness about the importance and dedication of tree protection efforts in Taiwan.

- From November 7 to 9, the TFRI's Lienhuachih Research Center held the forest healing field training course for volunteers of the Endemic Species Research Institute, attracting a total of 99 participants over two sessions.

- On November 9, Director General Chang Bin and the Chungpu Research Center team met with the Director of the Nantou Forest District Office, Forestry Bureau, Lee Cheng-Hsien, at the Sihu Coastal Workstation to conduct field inspection and exchange results. The meeting went over the effectiveness of the currently instated directives to remove African sacred ibises (Threskiornis aethiopicus), an invasive species, from Taiwan and the logistics to support said methods. The meeting served to draw the two parties closer together in order to further bolster directive implementation.

- On November 19, the TFRI's Chungpu Research Center held the "15th Environmental Protection Forest Management Conference" to provide a platform to exchange forestry research and techniques. It is hoped that through the exchange of opinions from different fields we can effectively control or improve the constantly deteriorating ecological environments of Taiwan.

- On November 20, TFRI's Technical Service Division held the first round of evaluation for the selection of demonstration sites for leisure farms and leisure agriculture areas for the "Project to Optimize the Agro-tourism in 2020." Field inspections were conducted from December 1 to 3, December 15, and December 21 to 23. The second round of evaluations took place on December 28. The four winning farms will start receiving consulting services in 2021.

- From November 22 to 24 and November 29 to December 1, Director General Chang Bin led research teams to conduct field surveys of the ecological system and rare organisms in the Kinmen and Matsu Islands. During the visit, in-depth discussions regarding the implementation of small island forestry took place with the Kinmen County Forestry Bureau and the Matsu Industrial Development Office; strategies for conserving unique regional species in the islands and commercializing them were also discussed.

- On November 22, TFRI's Lioukuei Research Center held the fourth quarterly learning course for Shanping volunteers and a field trip to the Chungpu Research Center. Assistant Researcher Tsai Ching-Chu shared his research on the "Practice of Identifying Trees Based on External Characteristics" and led the volunteers to visit the Bizihtou Botanical Garden and Chiayi Botanical Garden. The trip was very well received.

- On November 23, Associate Professor Duncan Wang from the Department of Recreation Management at Shih Chien University led 18 students from the University's environmental education program to visit the Lioukuei Research Center's subsidiary Shanping Forest Ecological Garden.

- On November 24, TFRI and the Council of Indigenous Peoples jointly held the "2020 Plant Raw Materials Summit & Matchmaking Conference" in the International Conference Hall of the TFRI Forestry Research Building.

- On November 25, the TFRI's Taimalee Research Center and Forest Protection Division jointly held a brown root rot disease prevention seminar to protect old Chinese banyan trees in Taitung County's Sanjiao Park from the disease, with Researcher Fu Chuen-Hsu from the Forest Protection Division as the lecturer.

- On November 25, the TFRI was awarded by President of the Executive Yuan, Su Tseng-Chang, for the Institute's "National Botanical Garden Project." The Project was chosen by the Council of Agriculture, Executive Yuan to enter the National Sustainable Development Awards, passing the preliminary evaluation of the National Sustainable Development Committee and the subsequent field evaluation at the Taipei Botanical Garden to receive the award as a government entity.

- On November 26, the TFRI's Forest Management Division conducted the "2020 Flatland Afforestation Experiment and Result Monitoring Seminar" in the meeting room on the fourth floor of the Administration Building, going over the challenges and adaptations of the Institute's flatland afforestation projects; using the Danongdafu Flatland Forest Park afforestation project as an example to illustrate the Institute's R&D progress in the fields of forest healing, landscape creation, ecological corridors, hybrid farm planning, fast-growing tree species nursing, and the effect of thinning on biodiversity.

- From November 27, 2020, to January 31, 2021, the TFRI held the "Senior Bamboo Paper and Pastel Event" in the sample paper exhibition room on the first floor of the Technical Service Building. The event had elders handcraft bamboo paper using domestic bamboo, and then create pastel paintings out of the DIY paper, which led to a variety of beautiful works being created through the observation and creativity of senior citizens.

- On November 28, the TFRI joined hands with the National Taiwan Library, New Taipei City Zhonghe District Office, and New Zhonghe Community College to hold the "Practice on Diversifying Shrub Plants in the Resilient Urban Forest Demonstration Site" event. The resilient urban forest volunteer team from New Zhonghe Community College added a total of 316 individual plants from 19 different shrubs and herbs to the 823 Memorial Park to enrich the park's urban forest structure, thereby boosting its ecological and social resilience.

- On November 29, the TFRI's Agricultural Innovation Incubation Center held a joint exhibition and sale event at the Hu-Tou Pei Scenic Area. The event was themed around accelerated incubation and ethical farming. This event helped the incubatees increase their brand exposure and product sales.

DECEMBER

- From December 1 to 2, the TFRI's Lienhuachih Research Center underwent its annual certification review from the Forest Stewardship Council (FSC). The Lienhuachih Research Center was able to pass the review and became FSC certified for 2020.

- From December 1 to 2, the TFRI's Lioukuei Research Center worked with the Chiayi Forest District Office, Forestry Bureau to hold the "Taiwania Man-made Intermediate Forest Thinning and Taiwan Tea Sapling Nursing Technique Exchange Forum" at the Liugui Experimental Forest. Center Director Chen Yun-Hsiu and District Office Director Chang Tai led the discussion and exchange of forestry technology along with research and technical staff from both organizations.

- On December 2, Director Hu Yuan-Wei from the TFRI's Taimalee Research Center was interviewed by Hakka TV to explain tree protection ordinances in Taiwan and the factors considered in the regulation of old trees. He also talked about the mission and contributions of the TFRI's Forest Disease Information Center.

- From December 3 to 6, the TFRI exhibited the "Aromatic Antibacterial Paper" developed by the Institute at the "2020 Healthcare+ Expo—Taiwan Agricultural Health Pavilion" held at the Taipei Nangang Exhibition Center.

- On December 8, the TFRI's Lienhuachih Research Center held its fourth quarterly volunteer ecology study and staff environmental education course, inviting Dr. Jiang Sheng-Sz from National Chung Hsing University and Assistant Researcher Lin Chien-Jung from the TFRI's Fushan Research Center as guest lecturers.

- The "Provincial Highway 9 Jinlun Bridge Protection Forest Restoration Project" entrusted to the TFRI from the Directorate General of Highways, MOTC concluded at the end of 2020. From December 9 to 10, the TFRI conducted the project's financial audit and conclusion review meeting, inviting relevant organizations to conduct field inspections and share their opinions.

- From December 11 to 12, the TFRI's Lienhuachih Research Center held an ecological study of the wetlands of northern Taiwan, visiting the two wetland areas each governed by Guandu Nature Park in Taipei City and New Taipei City's Wetland Story House.

- From December 22, 2020, to February 17, 2021, TFRI's Forest Management Division held the "Forests x Modernity—Scientific Narratives from Aerial Remote Sensing Images Exhibition" at the National Science and Technology Museum in Kaohsiung. The exhibition showcased various historic aerial photos of Kaohsiung taken by the U.S. Armed Forces. It was held alongside four special lectures.

- On December 22, the TFRI's Technical Service Division conducted an evaluation of all target sites for the "Project to Optimize the Agro-tourism in 2020." Technical Service Division Director Liu Yi-Xin and accompanying Council of Agriculture Members met at the Chungpu Research Center's subsidiary Sihu Coastal Botanical Garden, where council member Mr. Lee Tao-Sheng shared his experience managing the demonstration site with the Chungpu Research Center’s team.

- On December 27, resilient urban forest volunteer team members from the TFRI attended the "8th Ecological Shuanghe Carnival." They set up booths to provide interactive games and guided tours at the 823 Memorial Park to help share the vision and results of the Institute's resilient urban forest project with residents near the resilient urban forest demonstration site. The Carnival turned out to be a huge success and raised public willingness to support the 823 Memorial Park Resilient Urban Forest project.

國內外學者專題演講

日期	講　題	演講者	職稱	服務機關
01/16	從科研角度展望台灣林業發展	王升陽	特聘教授	國立中興大學農業暨自然資源學院森林學系
07/31	從大學社會責任談臺大實驗林經營	蔡明哲	處長	國立臺灣大學生物資源暨農學院實驗林管理處
09/23	台灣植物化石研究	李慶堯	助理教授	東方設計大學文化創意設計研究所
11/27	森林遊樂區之量化研究	柳婉郁	特聘教授	國立中興大學農業暨自然資源學院森林學系

科技研究專題演講

日期	講　題	演講者	職稱	服務機關
05/29	農林剩餘資材生物炭多元應用與效益評估計畫	林裕仁	研究員	林業試驗所
09/26	相思樹育種進展鍾振德	鍾振德	研究員	林業試驗所
09/26	台灣森林中雌雄異株木本植物的性別比例、空間分布與環境因子的關係之研究	張勵婉	副研究員	林業試驗所

出版品

圖書類｜林業叢刊

刊號	題名	作者	出版日
290	太陽照耀的肥沃土地—太麻里	胡元瑋、黃俊元、李銘鐘、楊蒼叡、賴政徽	6月
291	臺灣生物炭產製與農業應用指南	江汶錦、吳有恒、吳羽婷、吳耿東、李宜映、林文風 林裕仁、邱祈榮、倪禮豐、徐英綺、張敬宜、張廖伯勳 梁瑩如、陳韋辰、陳琦玲、陳鴻堂、黃文益、楊蔚因 劉俊宏、蔡正賢、鄭美如、龍暐、薛佑光、簡士濠	10月
292	椰子的葉蔭	川上瀧彌(蔡思薇 譯)	6月
293	2020森林集水區及環境監測研討會	曾俊偉	10月
294	2020 森林資源保存與利用論文集	游漢明、鍾振德	9月
295	108年度年報	林業試驗所年報編輯委員會	10月
296	森林療癒了誰？里山社區的行動參與	董景生	12月

非圖書類｜推廣摺頁

刊號	題名	作者	出版日
157	桉樹、相思樹、楓香、杜英優良品系之育苗體系	鍾振德、蔡佳彬、馬復京、游漢明	3月
158	非農業區裡的荔枝椿象 龍眼篇	徐孟豪、汪澤宏、吳孟玲、吳怡慧、蔡宇平、楊月鈴	9月
159	紙繡風華 格拉辛紙再次遇見紙繡特展	駱傳華、何振隆、徐光平、徐健國、沈匀薰	5月
160	福山試驗林常見大型蛾類	范義彬、劉一新、陸聲山	4月
161	扇平森林生態科學園賞蝶圖鑑	范義彬、朱榮三、李政賢、陳永修	10月
162	恆春半島的海濱及礁岩植物—草本篇	洪州玄、范義彬、潘東波	10月

非圖書類｜期刊

刊名	卷期（總號）	總編輯	出版日
台灣林業科學	35卷1期	陸聲山	3月
	35卷2期	陸聲山	6月
	35卷3期	陸聲山	9月
	35卷4期	陸聲山	12月
林業研究專訊	27卷1期	何振隆	2月
	27卷2期	何振隆	4月
	27卷3期	何振隆	6月
	27卷4期	何振隆	8月
	27卷5期	何振隆	10月
	27卷6期	何振隆	12月

109年技術移轉案件

技術名稱	單位	創作人	件數	授權種類	年限
香氛精油時空膠囊DIY製作技術	木材纖維組	何振隆	1	非專屬	3
深脈松露菌株之培養技術	森林保護組	林介龍	2	非專屬	3
深脈松露二葉松菌根鑑定技術	森林保護組	傅春旭	1	非專屬	3
深脈松露五葉松菌根接種技術	森林保護組	傅春旭	1	非專屬	3
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	2	非專屬	5
油茶快速成園技術	育林組	謝靜敏	1	非專屬	5
植物組織細胞水分低溫萃取製程	育林組	謝靜敏	2	非專屬	5
觀音樹種子苗培育技術	植物園組	楊正釧	1	非專屬	4
應用生物炭改良都市林土壤技術	森林利用組	林裕仁	1	非專屬	5
木質吸濕減臭材初步製作技術	森林利用組	林柏亨	1	非專屬	3
攀枝花松露的菌株分離培養技術	森林保護組	傅春旭	1	非專屬	5
天麻共生蜜環菌的培養技術	森林保護組	傅春旭	1	非專屬	3
赤皮種子苗培育技術	植物園組	楊正釧	1	非專屬	3
高效天然防蚊配方	森林化學組	洪昆源	1	非專屬	5
木藝創作組裝材料包及成品	森林經營組	王培蓉	1	非專屬	2
生產不同色澤之瓊崖海棠種仁油加工處理技術	育林組	馬復京	1	非專屬	5
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108年產學合作案件

計畫名稱	單位	主持人	執行期間
應用竹加工剩餘資材產製燃料顆粒計畫	森林利用組	林裕仁	109年1月1日至 109年12月31日

台灣林業科學

作者	英文題目	中文題目	頁數
Chyi-Rong Chiou Song-Ling Wang Sheng-Jie Yao Dai-Rong Lee、林裕仁	Case Study on Economic Evaluation of Gasification Investment Using Bamboo Processing Residue in Zhushan Area, Taiwan	竹加工剩餘資材氣化發電投資計畫之效益研究—以南投竹山地區為例	35(1): 13-36
黃勁暉、傅春旭、林介龍 張詠怡、李鎧彤	Phylogenetic Clusters of Commercial Blackish *Tuber* Species from Yunnan, China	雲南常見貿易黑塊菌的親緣及分群	35(1): 61-80
曾俊偉、陳起鳳、吳憶茹 林鎮洋	Application of a Stormwater Management Model (SWMM) to Assess the Water Resource Conservation Capability in the Deji Reservoir Watershed	應用集水區水文模式SWMM評估德基水庫集水區之水資源涵養量	35(2): 103-122
郭耀綸、張勵婉、林易養 余尚鈺	Relationships of Tree Species Associations with the Topography, Water Availability, and Species Drought Tolerance in the Lienhuachih Forest of Central Taiwan	台灣中部蓮華池森林樹種群聚與地形、水分有效性及樹種耐旱性的關係	35(2): 123-142
黃俊元、謝漢欽、陳朝圳 陳建璋	Effects of Fertilization, Light Environme, and Seedling Density on the Initial Growth of *Casuarina equisetifolia*	施肥、光環境及植株密度對木賊葉木麻黃初期生長之影響	35(2): 143-160
何雅齡、廖宇賡	*In vitro* Micropropagation of *Rhododendron kawakamii* Hay.	著生杜鵑之微體繁殖	35(2): 161-172
黃俊元、謝漢欽	Using NDVI and Landscape Metrics to Assess Impacts of Forest Land-Use in Shitan, Miaoli with Multi-Temporal FORMOSAT-2 Images	應用NDVI與地景指標評估林地利用的衝擊—以苗栗獅潭地區多期福衛二號影像為例	35(2): 173-191
王培蓉、張凱雯、婁安琪	Analysis of Factors Influencing Shaded Coffee Planting in Taiwan	影響林農栽植林蔭咖啡相關因子探討	35(3): 193-204
王相華、蘇聲欣、張勵婉	Spatial Patterns of Two Epiphytic Bird's-nest Ferns in a Moist Subtropical Forest, Northern Taiwan	兩種附生巢蕨在北台灣亞熱帶潮濕森林的空間分布特性	35(3): 205-216
黃文伯、楊懿如、葛兆年	The Influence of Plantation Growth on the Butterfly Community Structure	人工林成長對蝴蝶群聚組成結構的影響	35(3): 217-238
施欣慧、蔡佳彬、歐玠皜 李國維、傅春旭、陳啟予	First Report on Vascular Wilt of *Acacia confusa* in Taiwan	臺灣相思樹維管束萎凋病之首次報導	35(3): 251-255

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作者	題目	書名期刊	卷(期)、頁碼 審查編號	TCCC/ SCI/EI
劉庭瑋、廖敏君、曾喜育 董景生	原住民季節傳統知識的類型與應用	中華林學季刊	53(3): 137-154	其他
劉奕君、林晉陞、鄧書麟 王秋嫻	不同區域和季節對行道樹葉片不溶性滯塵量之影響	中華林學季刊	53(3): 105-120	其他
Andrew G. Murdock Cheng-Wei Chen、黃曜謀 David Glenny	Affinities of the fern genus *Ptisana* (Marattiaceae) in the Solomon Islands, with descriptions of two new species	PhytoKeys	170: 1-23	SCI
曾俊偉、Cheng-En Song Su-Fen Wang、Yi-Chin Chen Jien-Yi Tu、Chih-Wei Chuang Ci-Jian Yang	Application of High-Resolution Radar Rain Data to the Predictive Analysis of Landslide Susceptibility under Climate Change in the Laonong Watershed, Taiwan	Remote Sensing	2020, 12(23), 3855	SCI
張仲鈞、張勵婉、尤子豪 許愷岐、宋國彰	NDVI推估台灣森林葉面積指數之可行性評估	水土保持學報	50(4)	其他
游漢明、林冠穎	以林地土壤作為天然接種物對森氏櫟苗木根部真菌菌相之影響	林業研究季刊	42(4): 189-200	其他
陳蒼緯、尤子豪、張勵婉 宋國彰、曾玠皓、李信典 胡紘彥、葛千睿	台灣低海拔森林演替早期與晚期樹種根力比較	水土保持學報	50(4)	其他
Zheng-Feng Wang、Ju-Yu Lian Hong-Lin Cao、張勵婉	The complete chloroplast genome sequence of *Ormosia formosana*	MITOCHONDRIAL DNA PART B	2020, Vol. 5, No. 3	SCI
Tzu-Hao Su、Chin-Sheng Lin 林俊成、Chiung-Pin Liu	Dry deposition of particulate matter and its associated soluble ions on five broadleaved species in Taichung, central Taiwan	Science of the Total Environment	753: 141788	SCI
Sheng-Zehn Yang Po-Hao Chen、陳建帆	Cambial Variants Combine Successive Cambia and Intraxylary Phloem in Convolvulaceae in Taiwan	American Journal of Plant sciences	11, 437-453	
Chia-Hsuan Sung Sheng-Tai Hsiao、汪澤宏 Yasuhisa Henmi、Chang-Wen Huang	The complete mitochondrial genome of *Meretrix lusoria* (Bivalvia: Veneroida: Veneridae) from Kumamoto, Japan	Mitochondrial DNA Part B	5(3): 2451-2453	SCI
汪澤宏、徐孟豪、劉則言 Ming-Ying Lin、Chia-Hsuan Sung	Characterization of the complete mitochondrial genome of *Euwallacea fornicatus* (Eichhoff, 1868) (Coleoptera: Curculionidae: Scolytinae) and its phylogenetic implications.	Mitochondrial DNA Part B	5(3): 3520-3522	SCI
林冠穎、Chia-Yu Lin Su-Jein Chang、Wei-Yi Lin	The Dynamics of Endophytic Bacterial Community Structure in Rice Roots Under Different Field Management Systems	Agronomy	10(11), 1623	SCI
Y.S. Huang.、許富蘭	Analyses of cracking failure in curved laminated lumber due to transverse stress under a curvature-decreasing moment.	Results in Engineering	8: 100174	其它

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吳家禎、Shu-Hwa Chang Chih-Wei Tung、Cheng-Kuen Ho Yolanda Gogorcena、Fang-Hua Chu	Identification of hybridization and introgression between *Cinnamomum kanehirae* Hayata and *C. camphora* (L.) Presl using genotyping-by-sequencing	Scientific reports	10: 15995	SCI
Yi-Chiang Hsieh、Chung-Te Chang 鍾振德、Shih-Ying Hwang	Demographic history and adaptive synonymous and nonsynonymous variants of nuclear genes in *Rhododendron oldhamii* (Ericaceae)	Scientific Reports	10: 16658	SCI
Yu-De Liou、Shu-Tzong Lin 吳家禎	The complete chloroplast genome of native *Prunus campanulata* in Taiwan	MITOCHONDRIAL DNA PART B	VOL. 5, NO. 2	SCI
詹為巽、林俊成、邱祈榮 鄭可風	運用InVEST模擬土地利用變化對生態系服務效益之影響—以蓮華池地區為例	中華林學季刊	53(1): 1-18	其他
胡正恆、陳芬蕙	臺灣北部新店區一處生態茶園的地理特徵、茶葉成分與撫育管理之研究	中華林學季刊	53(1)	其他
Mei-Chen Chuang Hsiao-Wei Yuan、Ying Wang 蕭明堂	Seasonal rainfall in subtropical montane cloud forests drives demographic fluctuations in a Green-backed Tit population	Condor	Vol. 122	SCI
Kuo-Jen Chang、曾俊偉 Chih-Ming Tseng、Ta-Chun Liao Ci-Jian Yang	Application of Unmanned Aerial Vehicle (UAV)-acquired topography for quantifying typhoon-driven landslide volume and its potential topographic impact on rivers in mountainous catchments	Applied Sciences	10(17), 6102	SCI
鐘詩文、Wei-Jie HUANG 蘇惠昭	Rediscovery of *Lysimachia candida* Lindl. (Primulaceae) in Taiwan after 123 years	林業研究季刊	42(2): 119-126	其它
王經文、翁韶良、廖天賜 陳明男、陳忠義	水筆仔苗木於不同鹽度處理下光合誘導反應之探討	林業研究季刊	42(2): 91-104	其他
Ryuki Murao、Wen-Chi Yeh 陸聲山、I-Hsin Sung	Discovery of *Lasioglossum albescens* (Smith, 1853) (Hymenoptera, Halictidae) Halictidae) from the Kinmen Islands, Taiwan	Check List	16(4): 963-967	SCI
Cheng-Wei Chen、Minh Tri Dang Hong Truong Luu、Tzu-Tong Kao 黃曜謀、Chia-Wei Li	*Antrophyum nambanense*, A New Vittarioid Fern (Pteridaceae; Polypodiales) From Vietnam	Systematic Botany	45(3): 450-459	SCI
董景生、Yi-Chang Liao Daniel Burckhardt、Man-Miao Yang	*Trioza turouguei* sp. nov. (Hemiptera, Psylloidea, Triozidae), a new psyllid species from Taiwan inducing pea-shaped stem galls on *Cinnamomum osmophloeum* (Lauraceae), with notes on its galling biology	zookeys	958: 91-106	SCI
Ting-Kuang Chang、Chun-Ya Lin 陳盈如、Ting-Feng Yeh Shang-Tzen Chang	Rapid determination of S-(+)-linalool in leaf of *Cinnamomum osmophloeum* ct. linalool using ultrasound-assisted microextraction	Journal of Analytical Science and Technology	(2020) 11:36	SCI

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Pei-Chun Lee、Tze-Ying Chen Yu Chu、Wen-Liang Chiou 黃曜謀	Factors affecting longevity of spores of *Pentarhizidium orientale* (Hook.) Hayata, an endangered fern in Taiwan	The International Journal of Plant Reproductive Biology	12(2): 116-122	其它
何振隆、Lan-Hui Li Yueh-Chun Weng、Kuo-Feng Hua Tz-Chuen Ju	*Eucalyptus* essential oils inhibit the lipopolysaccharide-induced inflammatory response in RAW264.7 macrophages through reducing MAPK and NF-κB pathways	BMC Complementary Medicine and Therapies	20: 200	SCI
徐光平、Yu-Chang Su、何振隆	Chemical Compositions and In Vitro Antiphytopathogenic Fungi Activities of the Leaf and Cones Essential Oils of *Cunninghamia lanceolata* From Taiwan	Natural Product Communications	15(6): 1-9	SCI
張坤城、龔冠寧	*Piper lanyuense* (Piperaceae), a new species from Taiwan	Annales Botanici Fennici	57: 93-96	SCI
Sangjun Im、Jeman Lee 曾俊偉、Yen-Jen Lai、Venus Tuankrua、Koichiro Kuraji Nobuaki Tanaka、Mie Gomyo Hiroki Inoue	Soil conservation service curve number determination for forest cover using rainfall and runoff data in experimental forests	Journal of Forest Research	JRES-D-19-00200R4	SCI
鐘詩文、Wei-Jie HUANG1 許天銓	*Aster kanoi* (Asteraceae, Astereae), a new species from Taiwan, with lectotypification and morphological emendation of *Aster takasagomontanus*	Taiwania	65(3): 315–320	SCI
Lin Li、鐘詩文、Bo Li Song-Jun Zeng、Shi-Jin Li	New insight into the molecular phylogeny of the genus *Liparis* s.l. (Orchidaceae: Malaxideae) with a new generic segregate: *Blepharoglossum*	Plant Systematics and Evolution	(2020) 306:54	SCI
陳柏豪、鍾安晴、王志強 楊勝任	*Commelina erecta* L. (Commelinaceae), a newly naturalized species in Taiwan	Taiwan Journal of Biodiversity	22(2): 151-158	其他
Ching-An Chiu、Mei-Fen Lee Chen-Chang Pan、Kuo-Min Fu 陸聲山	Reusing indigenous plant materials to restore vegetation: A practical case in Shei-Pa National Park	Journal of Asia-Pacific Biodiversity	13: 175-181	SCI
彭元興、徐健國	市售造紙用紙漿概論	漿紙技術	24(1)	其他
彭元興、徐健國	市售針葉樹紙漿選擇的訣竅	漿紙技術	24(1)	其他
何振隆、徐光平、蘇裕昌	精油微膠囊應用於香氛精油特種紙之介紹	漿紙技術	24(1)	其他
Chieh-Ting Wang、謝靜敏 Lang-Dong Lin、Yu-Wei Yeh Roland Kirschner	New records of two fungal pathogens associated with premature leaf fall of two varieties of *Ficus pumila* in Taiwan	Fung. Sci.	35(1): 9–16	其他

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Chung-Te Chang、Pei-Jen Shaner 王相華、Teng-Chiu Lin	Resilience of a subtropical rainforest to annual typhoon disturbance: Lessons from 25-year data of leaf area index	Forest Ecology and Management	470-471: 118210	SCI
Po-Hao Chen、鍾安晴 Sheng-Zehn Yang	First report of the root parasite *Cansjera rheedei* (Santalales: Opiliaceae) in Taiwan	Biodiversity Data Journal	8: e51544	SCI
Zhi-Xiang CHANG Li-Yaung KUO、Pi-Fong LU 黃曜謀	New addition to the *Asplenium normale* complex (Aspleniaceae): an endemic forma in Taiwan	Taiwania	65(2): 253-260	SCI
Ching-Chu Tsai、Li-Fen Hung 鍾振德、Wen-Yuan Kao Ling-Long Kuo-Huang	Regulation of tree crown phenology and fruit set of *Cinnamomum kanehirae* Hayata an endangered evergreen tree in Taiwan	Taiwania	65(1): 15–26	SCI
許天銓、CHUN-KUEI LIAO WEI-JIE HUANG、鐘詩文	*Silene ohwii* (Caryophyllaceae), a replaced name for *Melandrium nubigenum*	Phytotaxa	432 (3): 296-300	SCI
Pei-Lin Chiang、Ying-Chuan Kao 許富蘭、Jia-Yang Juang Yan-San Huang	Cracking failure of curved hollow tree trunks	Royal Society Open Science	Apr; 4(4): 160972.	SCI
Jung-Tai Lee、Ming-Yang Chu Yu-Syuan Lin 、龔冠寧 Wen-Chi Lin、Ming-Jen Lee	Root Traits and Biomechanical Properties of Three Tropical Pioneer Tree Species for Forest Restoration in Landslide Areas	Forests	11(2) 179-197	SCI
邱明賜、楊德新、林振榮	茶葉塑膠再生複合材之開發研究	臺灣茶業研究彙報	第38號：183-192	其他
林奐宇、Ching-Feng Li Tze-Ying Chen、Chang-Fu Hsieh Guangyu Wang、Jer-Ming Hu Tongli Wang	Climate-based approach for modeling the distribution of montane forest vegetation in Taiwan	Applied Vegetation Science	online published	SCI
蘇聲欣、Chia-Hao Chang-Yang I-Fang Sun、王相華 Biing T. Guan、Chang-Fu Hsieh	Multi-stemming and size enhance survival of dominant tree species in a frequently typhoon-disturbed forest.	Journal of Vegetation Science	31(3): 429-439	SCI

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R. A. Chisholm K. Anderson-Teixeira、N. Bourg 蘇聲欣、Tak Fung W. Y. Brockelman S. Bunyavejchewin C.-H. Chang-Yang、R. Chitra-Tarak G. Chuyong、R. Condit H. S. Dattaraja、S. J. Davies C. E. N. Ewango、G. Fewless C. Fletcher、C. V. S. Gunatilleke I. A. U. N. Gunatilleke Z. Hao, J. A. Hogan R. Howe, C.-F. Hsieh D. Kenfack, Y. Lin, K. Ma J.-R. Makana、S. McMahon W. J. McShea、X. Mi, A. Nathalang、P. S. Ong、G. Parker E.-P. Rau, J. Shue、R. Sukumar I.-F. Sun、H. S. Suresh、S. Tan D. Thomas、J. Thompson R. Valencia、M. I. Vallejo X. Wang、Y. Wang、P. Wijekoon A. Wolf、S. Yap、J. Zimmerman	Temporal population variability in local forest communities has mixed effects on tree species richness across a latitudinal gradient.	Ecology Letters	23(1): 160-171	SCI
林奐宇、Yu-Hsin Tseng Chang-Fu Hsieh、Jer-Ming Hu	Geographical distribution of dioecy and its ecological correlates based on fine-scaled species distribution data from a subtropical island	Ecological Research	35: 170-181	SCI
C.G. Mayers 、T.C. Harrington H. Masuya、B.H. Jordal 施欣慧、D.L. McNew F. Roets、G.J. Kietzka	Patterns of coevolution between ambrosia beetle mycangia and the *Ceratocystidaceae*, with five new fungal genera and seven new species	Persoonia: Molecular Phylogeny and Evolution of Fungi	44: 41-66	SCI

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黃靖倫、伍淑惠、蔡育倫 張智偉	109年森林資源永續發展研討會	野生動物對不同地景棲地之利用—以森林型里山為範例	中華林學會 國立中興大學森林學系
鍾振德、蔡佳彬、許原瑞	2020平地造林試驗及監測研討會	不同桉樹品系之培育與生長檢測	林業試驗所
王巧萍	動物行為與生態學研討會	土壤動物能不能拯救土壤劣化	國立澎湖科技大學水產養殖系
洪昆源、范義彬、蔡景株 吳芯慧	第35屆天然藥物研討會暨第3屆杜聰明博士醫學論壇	The Natural Component of Plant Essential Oils Combined with Music Therapy More Effect on Nerve Cells	台北醫學大學
王培蓉	大農大富平地森林園區生態產業整合論壇	大農大富平地森林資源規劃與開發活化策略	林務局花蓮林區管理處
王培蓉、婁安琪、王韻皓 嚴晟瑋	2020平地造林試驗及監測研討會	獎勵平地造林政策的推行效果及發展策略	林業試驗所
張彬、王培蓉、彭炳勳	2020平地造林試驗及監測研討會	平地造林試驗監測計畫成效與轉向	林業試驗所
楊正釧、蕭崇仁、楊婉辰 劉惠宜	第15屆環境保護林經營管理研討會	台灣正儲型林木種子的儲藏策略—以東勢林管處庫存種子為例	林試所中埔研究中心
湯適謙、謝漢欽、王相華	2020平地造林試驗及監測研討會	無人機空載光達於平地造林材積估算之應用	行政院農業委員會林業試驗所
王相華、杜清澤、湯適謙 黃菊美、陳一銘、謝靜敏	2020平地造林試驗及監測研討會	平地造林補助期滿林地之混農林經營規劃及實務作業初探	林業試驗所
鄭雨柔、謝亦棠、蔡景株 鄧書麟	第十五屆環境保護林經營管理研討會	台灣原生植物果實、種子製作典藏與展示	中埔研究中心
蔡景株、龔冠寧、洪昆源 蔡宗文、鄧書麟	第十五屆環境保護林經營管理研討會	校園植樹環境調查研究-以雲林縣國小為例	中埔研究中心
彭炳勳、唐盛林、邱志明 蔣華蕾	2020平地造林試驗及監測研討會	以常態化差異植生指標推估屏東花蓮平森園區周邊蓄積量之初探	林業試驗所
陳一銘、葛兆年、李佾玲	2020平地造林試驗及監測研討會	大農大富生態廊道之演進與經營建議	林業試驗所

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陳巧瑋、洪聖峰、楊慶雲 林照松	第十五屆環境保護林經營管理研討會	梅花鹿啃食環剝皮孫木之因應措施	林業試驗所中埔研究中心
黃俊元、賴政徽、謝漢欽	第十五屆環境保護林經營管理研討會	109年一臺東金崙高架橋下三種海岸樹種復舊造林初期生長表現之探討	林業試驗所中埔研究中心
張怡萱、吳進益、劉癸君 鄧書麟	第十五屆環境保護林經營管理研討會	中港園區整體景觀攜手計畫—綠帶經營的過去、現在與未來	中埔研究中心
李金梅、林振榮、何振隆 黃國雄	109 年森林資源永續發展研討會	9種臺灣常見木材之物理性質	中華林學會
巫思伃、郭彥甫、李金梅	2020中華林產事業協會學術論文暨研究成果研討會	卷積神經網路於木材辨識研究之初探	中華林產事業協會
吳孟珊、王培蓉、詹為巽	109年森林資源永續發展研討會	林農對森林生態系服務支付認知之研究	中華林學會 國立中興大學森林學系
林柏亨、C. Lin、C. Ko F. Chang	The 4th Sustainable Process Integration Laboratory Scientific Conference	Pyrolysis properties of wood mixed waste rigid polyurethane foam pellet	
T. Tu、B. Yang、林柏亨 C. Ko、T. Nakai	The 4th Sustainable Process Integration Laboratory Scientific Conference	Carbon sequestration and retention of particulate matter by young urban forests in Nantou, Taiwan	
顧文君、林柏亨、傅春旭	109年森林資源永續發展研討會	陰香不同器官主要成分之研究	
李俊緯、黎明儀、徐霈馨 董景生、陸聲山	2020平地造林試驗及監測研討會	林園療癒的社區參與—大農大富平地森林案例探討	行政院農業委員會林業試驗所
吳孟玲	International Forum on Remote Sensing and Digital Solutions for Greenspace Management	The website of health and risk assessment of urban forest in Taiwan	內政部地政司委託台灣地理資訊中心辦理
陳怡蒨、陳媗、張淑華 何政坤、蔡錦瑩	中華林學會109年森林資源永續發展研討會	土肉桂組培莖芽低溫保存研究	中華林學會 中興大學
陳芬蕙、許富蘭、許俊凱 江敬晧、	2020平地造林試驗及監測研討會	造林地蜂箱附近物候與森林蜜揮發成分之初探	林業試驗所森林經營組
吳茹安、陳芬蕙	中華林學會109年森林資源永續發展研討會	陽明山地區華八仙物候觀察及扦插繁殖試驗初探	中華林學會

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謝漢欽、湯適謙	International Forum on Remote Sensing and Digital Solutions for Greenspace Management	Applications of terrestrial LiDAR and satellite imagery to urban forest inventory	內政部地政司委託台灣地理資訊中心辦理
謝漢欽、黃俊元、湯適謙	第15屆環境保護林經營管理研討會	應用福衛五號衛星影像分析六都都會區綠覆率	林試所中埔研究中心
范素瑋	2020台灣植物分類學會年會暨研討會	臺北植物園如何透過空間經營及植物蒐藏打造新印象	社團法人台灣植物學分類學會
徐中芃、王淑瑩	2020平地造林試驗及監測研討會	融入在地居民的風景營造：以花蓮大農大富平地森林為例	林試所森林經營組
范素瑋	國家植物園方舟計畫2020保種實務交流研討會	臺北植物園受威脅植物的採集、培育與繁殖	行政院農業委員會林業試驗所
王相華、施郁庭、傅淑瑋 呂克勤	中華林學會109年森林資源永續發展研討會	人類活動對鳥類多樣性的影響—以台灣北部沿海三處山村為例	中華林學會
吳孟玲	都市樹木健康檢查與風險管理論壇	都市樹木健檢及風險管理	行政院農業委員會林業試驗所、台南市政府農業局、台南市政府工務局、社團法人都市林健康美化協會
葛兆年、盧勇仁	動物行為與生態學研討會	北海岸山村不同棲地類型之昆蟲相探討	國立澎湖科技大學
呂克勤、葛兆年、洪美珠	農業生態系長期生態研究研討會	應用無人機影像評估水稻秧苗缺損量	農業試驗所
Hsien-Hung Chang Chih-Li Chen、Ying-Chi Du Mohamed El-Shazly Yu-Hsuan Lin、傅春旭 張東柱	第35屆天然藥物研討會	Phytochemical Analysis of Wood-Cultivated Antrodia salmonea Fruiting Bodies	台北醫藥大學
Chih-Li Chen Mohamed El-Shazly Hsien-Hung, Chang Ying-Chi Du、Yu-Hsuan Lin 張東柱、傅春旭	第35屆天然藥物研討會	Mycobiont Isolation, Identification, Liquid Culture and Phytochemical Analysis of Armillaria sp. from Gastrodia elata	台北醫藥大學
林裕仁、鍾易霖、柳婉郁	109年森林資源永續發展研討會	應用技術經濟分析法評估桂竹加工剩餘資材再利用經濟價值	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
Ren-Bao Liaw Ming-Hui Chang、何振隆 林裕仁、En-Lieng Lau Jeng-Fang Huang	International Symposium on The Practice and Benefits of Circular agriculture in Waste Reducing and Recycling	Technology development of circular agriculture	Taiwan Livestock Research Institute (TLRI) Food and Fertilixer Technology Center (FFTC)
連鈞皓、汪澤宏、蘇庭弘 林世宗、鍾智昕	2020平地造林試驗及監測研討會	平地造林之光蠟樹與楓香樹冠結構特徵研究	林業試驗所
黃愷茹	質性研究「公」作坊：一場與方法的對話 研討會	從對話到辯證、從實踐的知識到科學實踐—論行動研究方法及其應用在臺灣公共行政領域研究的可能性	國立政治大學社會科學學院 國立政治大學公民社會暨地方治理研究中心
Cang-Wei Chen、張勵婉 Guo-Zhang M. Song Chien-Jui Ko、Hsin-Tien Lee Hung-Yen Hu、Jie-hao Tseng	EGU2020	Root strength comparison between early and late successional trees in a subtropical forest	
Hsin-Tien Lee Guo-Zhang M. Song 張勵婉、Cang-wei Chen Hung-Yen Hu	EGU2020	Building regression models to estimate tree traits influential to slope stability	
葛兆年、傅淑瑋、陳一銘 王相華	2020平地造林試驗及監測研討會	人工林塊狀疏伐短期內對生物多樣性的影響—以大農大富平地造林為例	林業試驗所
楊穎浩、許富蘭、張資正	109年森林資源永續發展研討會	菲島福木可再生部位開發為天然防曬添加劑之可行性評估	中華林學會
張勵婉、黃曜謀、廖宇賡 徐露玉、盧仁勇、陳一銘	2020平地造林試驗及監測研討會	花蓮大農大富平地森林園區寬葉毛氈苔之族群監測、復育與植物資源利用植物資源利用	
張勵婉、莊銘豐、蘇塏瑞 余尚鈺、陳建文、鄭美如	第15屆環境保護林經營管理	環境感測網絡應用於生物監測之研究	
張勵婉、王培蓉、王巧萍 余尚鈺	2020亞太女科技人會議暨國際女科技人研討會APNN & IConWiST	Women in the forestry career field in Taiwan	
張勵婉、陳建文、鄭美如 余尚鈺	2020森林集水區及環境監測研討會	數位物候學(e-phenology)的監測與應用	
吳孟玲、徐孟豪、劉則言	2020植栽及樹木之健檢與醫療研討會	樹木健康平台建立	林業試驗所

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作者	研討會名稱	論文題目	主辦單位
徐孟豪、蔡宇平、汪澤宏 吳孟玲	2020植栽及樹木之健檢與醫療研討會	光週期與氣候對都市林荔枝椿象族群消長之影響	林業試驗所
詹為巽、盧學甫、林俊成	中華林學會109年森林資源永續發展研討會	臺灣都市樹木效益運用i-Tree估算之適用性—以碳儲存為例	
詹為巽、林俊成、吳孟珊	中華林學會109年森林資源永續發展研討會	以延伸計畫行為理論探討居民對都市樹木之保育行為意向	
張琮柏、鄧書麟、林建宗 李育潔、張坤城	109年森林資源永續發展研討會	利用殘材DNA鑑定阿里山集材柱之樹種	中華林學會 國立中興大學森林學系
龔冠寧、許淯淳、鄧書麟 張坤城、陳威廷	林業試驗所中埔研究中心第十五屆環境保護林經營管理研討會	雲林縣沿海地區中小學校園樹木調查與分析—以麥寮鄉、臺西鄉、四湖鄉及口湖鄉為例	林業試驗所中埔研究中心
龔冠寧、鄧書麟、李育潔 陳永修、張琮柏	109年森林資源永續發展研討會	六龜試驗林臺灣山茶採收效益與評估	中華林學會 國立中興大學森林學系
黃愷茹、潘孝隆	2020年第十五屆台灣公共行政與公共事務系所聯合會年會暨國際學術研討會	公共工程生態友善量表之建立	臺灣公共行政與公共事務系所聯合會 國立臺南大學行政管理學系
陳建帆、蘇迎晨、廖敏君 藍姆路・卡造	中華林學會109年森林資源永續發展研討會	經營管理方式與生育地特性對水梯田植相組成與多樣性效應：以臺灣東部吉哈拉艾文化景觀為例	中華林學會
陳品何、廖敏君、徐霈馨 洪宗佑、陳瑋苓、趙芝良 盧道杰	中華林學會109年森林資源永續發展研討會	南投縣信義鄉望鄉部落里山地景變遷初分析	中華林學會
廖敏君、方韻茹 藍姆路・卡造、董景生	中華林學會109年森林資源永續發展研討會	初探都市林的角色—以都市綠地活動民眾特性為例	中華林學會
王巧萍、陳鼎文、林冠穎 張明暉	2020台灣微生物生態學學會與中華民國真菌學會聯合年會暨應用微生物研討會	黃頸蜷蚓對於不同理化性質之土壤微生物群落結構的影響	臺灣微生物生態學會 中華民國真菌學會
劉承熹、黃曜謀	中華林學會109年森林資源永續發展研討會	十大功勞種子成熟度與發芽力之關係	中華林學會
李哲宇、高育茹、陳筠 黃曜謀、劉以誠	中華林學會109年森林資源永續發展研討會	除了孢子還有更多的選擇—臺灣原生蕨類的不定芽	中華林學會

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作者	研討會名稱	論文題目	主辦單位
陳筠、黃曜謀、李佩純 邱文良、汪春美	中華林學會109年森林資源永續發展研討會	東方萸果蕨孢子成熟度對於活力之影響	中華林學會
李沛軒、黃曜謀、邱文良	中華林學會109年森林資源永續發展研討會	特有瀕危蕨類臺灣觀音座蓮托葉營養繁殖	中華林學會
柯品安、黃曜謀、廖宇賡	中華林學會109年森林資源永續發展研討會	建立臺灣水龍骨綠球體繁殖系統	中華林學會
婁安琪、徐中芃、王培蓉 王韻皓	中華林學會109年森林資源永續發展研討會	與自然共生之森林永續經營策略	中華林學會
陳柏蓉、婁安琪、王韻皓 王培蓉	中華林學會109年森林資源永續發展研討會	國產材集材、製材與產銷聚落模式初探	中華林學會
嚴晟瑋、唐盛林、王培蓉 李隆恩	中華林學會109年森林資源永續發展研討會	參加獎勵平地造林及期滿後續前後期林農態度之變化—以花蓮縣為例	中華林學會
李隆恩、陳淯婷、王韻皓	中華林學會109年森林資源永續發展研討會	臺灣杉人工林單木生長與競爭關係之研究	中華林學會
李隆恩、陳淯婷、唐盛林	中華林學會109年森林資源永續發展研討會	都市樹木風險評估與管理—以新北市中和公園為例	中華林學會
蘇聲欣	中華林學會109年森林資源永續發展研討會	臺灣樹種木材基礎性質資料庫之建置	中華林學會
蔡景株、謝亦棠、鄭雨柔 鄧書麟	國家植物方舟計畫2020保種實務交流研討會	中埔研究中心轄區植物園方舟計畫整建工程現況與未來	林業試驗所
謝亦棠、蔡景株、鄭雨柔 鄧書麟	管理國家植物方舟計畫2020保種實務交流研討會	阿里山十大功勞採集與培育	林業試驗所
鄭雨柔、蔡景株、謝亦棠 鄧書麟	國家植物方舟計畫2020保種實務交流研討會	方舟植物果實、種子典藏與展示	林業試驗所
彭炳勳、郭家和、陳建璋	中華林學會109年森林資源永續發展研討會	花蓮大農大富地區楓香人工林胸高形數與形率之關係探討	國立中興大學
徐謙、陸聲山、蕭旭峰	第41屆台灣昆蟲學會年會_仿生科學	黃喙蜾蠃(膜翅目：胡蜂科)築巢空間與築巢策略研究	台灣昆蟲學會 國立臺灣科學教育館
黃冠瑋、蔡佳彬、薛桂茹 林清山、陸聲山、宋一鑫	第41屆台灣昆蟲學會年會_仿生科學	嘉義、台南樹木苗圃之小蠹蟲調查	台灣昆蟲學會 國立臺灣科學教育館

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作者	研討會名稱	論文題目	主辦單位
陸聲山、葉文琪、林依靜 呂明倫、黃靜宜、宋一鑫	第41屆台灣昆蟲學會年會_仿生科學	雙色虎頭蜂在台灣的入侵現況與威脅	台灣昆蟲學會 國立臺灣科學教育館
Erin Krichilsky、Wen-Chi Yeh I-Hsin Sung、陸聲山 Chung-Ping Lin、John Wang	第41屆台灣昆蟲學會年會_仿生科學	The Bees of Taiwan	台灣昆蟲學會 國立臺灣科學教育館
劉宇軒、施郁庭、江曜宇 王相華	2020森林集水區經營及環境監測研討會	都市林在夏季期間的降溫效應初探—以中和公園及台北植物園為例	林業試驗所
江曜宇、王秋嫻、施郁庭 呂克勤、王相華	2020森林集水區經營及環境監測研討會	宜蘭雙連埤地區水體中可溶性無機氮與土地利用之關係	林業試驗所
林建融	台灣植物分類的時光之旅：植物標本館和植物園(2020台灣植物分類學會年會暨研討會)	台灣國家型植物移地保種計畫—國家植物園方舟計畫	社團法人臺灣植物分類學會
林建融、黃俊嘉、徐怡德	國家植物園方舟計畫保種實務交流研討會	福山植物園水社野牡丹移地保育現況	林業試驗所
林建融、潘旻翰、朱麗萍	國家植物園方舟計畫保種實務交流研討會	福山植物園水生植物保種場域規劃	林業試驗所
吳孟玲	韌性城市國際論壇	都市林健康風險管理平台介紹	林業試驗所
蔡宇平、徐孟豪、吳孟玲	韌性城市國際論壇	都市綠地空間的生心理健康效益	林業試驗所
范義彬	2020環境保護林研討會	環境保護林自然探索教育模式之建立	林業試驗所 中埔研究中心
徐光平、何振隆	科學開門—青春不悶KISS SCIENCE	木材的溫柔變身—精油萃取與應用	台大森林系 林業試驗所
李俊緯、董景生	國家植物園方舟計畫保種實務交流研討會	國家植物園方舟計畫之行銷策略與推廣實務	林業試驗所
林冠穎、林維怡	台灣農藝學會109 年年度會員大會作物科學講座暨研究成果發表會	苗栗地區耕作模式與生育時期對水稻根部內共生菌相之影響	台灣農藝學會
陳可芳、張藝翰、葉定宏 林照松	國家植物園方舟計畫2020年保種實務交流研討會	生與死的固執	行政院農業委員會林業試驗所

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作者	研討會名稱	論文題目	主辦單位
張藝翰、陳可芳、葉定宏 林照松	國家植物園方舟計畫2020年保種實務交流研討會	恆春熱帶植物園珍稀植物蒐培現況與未來園區保種之擘劃	行政院農業委員會林業試驗所
董景生	走讀臺灣論壇	日安，台北之晨—出發探險去	國立臺灣博物館
林郁庭、徐惠群、闕雅文 董景生	2020年環境教育研討會	提升自然覺知之永續發展教育教學模組設計—德國動物生活教案之轉化	中華民國環境教育學會
伍淑惠、陳可芳	國家植物園方舟計畫2020保種實務交流研討會	稀有植物大血藤(*Mucuna gigantea*)保育生物學研究	行政院農業委員會林業試驗所
伍淑惠、黃朝卿	國家植物園方舟計畫2020保種實務交流研討會	政治與政策？海米(*Carex kobomugi*)的處境與未來	行政院農業委員會林業試驗所
顧文君、傅春旭、林振榮 林柏亨	2020森林資源保存與利用研討會	陰香主要化學成分之研究	林業試驗所
顧文君、馬復京、林振榮 林柏亨	2020森林資源保存與利用研討會	瓊崖海棠鮮花萃取物與抗氧化成分之研究	林業試驗所
房浩、洪聖峰、陳巧瑋 鄭舒婷	2020森林資源保存與利用研討會	銹葉野牡丹種子繁殖初探	林業試驗所
馬復京、陳媜、蔡彥新 林怡辰、游漢明	2020森林資源保存與利用研討會	以香菇、木耳菌種孵育杜英種子發芽及休眠性的探討	林業試驗所
陳芬蕙、吳茹安	2020森林資源保存與利用研討會	韌性都市林具調適功能本土性樹種盤點之初探	林業試驗所
王培蓉、嚴晟瑋、唐盛林 王韻皓	2020森林資源保存與利用研討會	期滿後平地造林何去何從—花蓮縣參與獎勵造林農的調查報告	林業試驗所
黃俊堯、陳怡蒨、許俊凱 蔡佳彬、孫英玄	2020森林資源保存與利用研討會	臺灣山胡椒性別辨認分子標記之開發	林業試驗所
吳家禎、Jung-Min Chang Shu-Hwa Chang Cheng-Kuen Ho Fang-Hua Chu	2020森林資源保存與利用研討會	Development of microsatellite markers and analysis of interspecific genetic variability in *Cinnamomum kanehirae* Hayata	林業試驗所
林冠穎、游漢明	2020森林資源保存與利用研討會	森氏櫟根部真菌菌相ITS序列定序分析	林業試驗所

研討會報告

作者	研討會名稱	論文題目	主辦單位
文起祥、歐書寰、李宜儒 曲芳華	2020森林資源保存與利用研討會	楓香黃酮醇生合成基因調控	林業試驗所
周立人、杜清澤、劉瓊霰	2020森林資源保存與利用研討會	土壤酸性磷酸酶與土壤中有效磷及苗木生長之關係	林業試驗所
杜清澤、徐嘉君、黃菊美 謝漢欽	2020森林資源保存與利用研討會	臺灣地區國有林地之土壤反應	林業試驗所
李俊佑、林子超、游漢明	2020森林資源保存與利用研討會	菌根菌是不是造林的幫手？—系統文獻回顧及後設分析的初步結果	林業試驗所
邱予柔、黃菊美、劉瓊霰	2020森林資源保存與利用研討會	水凝膠與泥炭土改善苗木受乾旱逆境之效應	林業試驗所
蔡佳彬、傅春旭、陳啟予 施欣慧	2020森林資源保存與利用研討會	臺灣相思樹萎凋病之研究初探	林業試驗所
蔡佳彬、鍾振德、杜清澤 江曜宇、游漢明、張森 孫英玄	2020森林資源保存與利用研討會	相思樹優良母樹後裔之初期生長	林業試驗所
鍾振德、蔡佳彬、孫英玄 陳盈全、林鴻志	2020森林資源保存與利用研討會	台灣杉單親後裔試驗與精英樹選拔	林業試驗所
張勵婉、伍淑惠 Trevor Padgett	2020森林資源保存與利用研討會	雌雄異株木本植物茄苳、毛柿的性別偏倚與性別轉換現象	林業試驗所
馬復京、蔡彥新、林怡辰 游漢明	2020森林資源保存與利用研討會	杜英種子層積處理組合及種源單株發芽率與催芽時程的差異	林業試驗所
謝靜敏、馬復京	2020森林資源保存與利用研討會	杜英果實的發育與成熟解剖觀察	林業試驗所
蔡政孝、陳芬蕙	2020森林資源保存與利用研討會	高雄寶山地區不同林下環境對臺灣山茶經營之收穫表現	林業試驗所
鍾安晴、周富三、郭耀綸 林文智	2020森林資源保存與利用研討會	莫拉克颱風十年後崩塌地樹木及苗木之組成與結構	林業試驗所
周富三、林文智、朱榮三	2020森林資源保存與利用研討會	臺灣山茶種子的發育與充實	林業試驗所
韓承真、潘嫈穎、陳芬蕙 江敬皓、許俊凱、許富蘭	第50次(第25屆第2次)台灣食品科學技術學會年會	大溪不同蜂箱未濃縮森林蜜揮發成分比較	台灣食品科學技術學會

研討會報告

作者	研討會名稱	論文題目	主辦單位
潘嫈穎、陳盈如、韓承真 許富蘭	第50次(第25屆第2次)台灣食品科學技術學會年會	固相微萃取(SPME)分析蜂蜜揮發成分之吸附條件最適化	台灣食品科學技術學會
李志璇、林振榮、林世宗 游佳軒、婁潤庭、林子諾 陳廷安、鍾智昕	2020森林資源保存與利用研討會	海岸防風林植被冠層垂直結構對減風效果之研究	林業試驗所
王偉、邱清安、張芷寧 廖敏君、張之毅、曾喜育	中華林學會109年森林資源永續發展研討會	陽明山國家公園向天山火山口植群研究	中華林學會
陳水龍、彭弘遠、林振榮	2020第18屆大地工程學術研討會	透地雷達應用於立木檢測	大地工程學會
黃曜謀、邱文良、張藝翰	第十一屆台灣濕地生態系研討會	夢幻湖土壤中臺灣水韭球莖之空間分布及活力	台灣濕地學會
李沛軒	國家植物園方舟計畫2020保種實務交流研討會	蕨類植物採集與繁殖	林業試驗所植物園組
蘇子豪、曾俊偉、龔聖皓 廖晨喬、劉瓊霰	2020森林集水區及環境監測研討會	不同植生覆蓋對水文環境之影響	林業試驗所
莊智瑋、曾俊偉	2020森林集水區及環境監測研討會	野火熱點空間區位萃取之研究	林業試驗所
曾俊偉、鍾智昕	2020森林集水區及環境監測研討會	應用open data cube遙測資料與植生指標於海岸林變遷分析	林業試驗所
朱麗萍、江友中	2020保種實務交流研討會	台灣萍蓬草族群遺傳變異分析	林業試驗所
傅淑瑋、葛兆年、丁宗蘇	2020 農業生態系長期生態研究研討會	從eBird公民科學資料初探台北市不同土地覆蓋的鳥類多樣性	行政院農委會農業試驗所
李育潔、鄧書麟、龔冠寧 蔡景株	國家植物園方舟計畫2020保種實務交流研討會	海南草海桐採集與培育	林業試驗所
龔冠寧、李育潔、鄧書麟 蔡景株	國家植物園方舟計畫2020保種實務交流研討會	四湖海岸植物園方舟計畫之經營管理與未來願景	林業試驗所
范義彬、劉明昇	台灣濕地研討會	華江雁鴨自然公園開花物候監測調查	台灣濕地學會 中國文化大學
董景生、林奐宇、許巧穎 廖敏君	國家植物園方舟計畫2020保種實務交流研討會	國家植物園方舟計畫的採集倫理與後設採集	林業試驗所

研討會報告

作者	研討會名稱	論文題目	主辦單位
林奐宇	2020森林集水區經營研討會	以氣候資料為基礎的臺灣山地森林植群分布模型	林業試驗所
林奐宇、張名宗、李昆達 董景生	國家植物園方舟計畫2020保種實務交流研討會	瀕危植物琉球暗羅現生族群之航空與地面調查初探	林業試驗所
林奐宇	國家植物園方舟計畫2020保種實務交流研討會	國家植物園方舟遷地保育物種資料管理平臺設計概念及其應用	林業試驗所
廖敏君、吳維修、范素瑋 董景生	國家植物園方舟計畫2020保種實務交流研討會	國家植物園方舟計畫植物保種應用—以今日我最美為例	林業試驗所
傅淑瑋、葛兆年、許詩涵	2020動物行為與生態學研討會	大農大富平地森林園區塊狀疏伐處理對鳥種多樣性及組成之影響	國立澎湖科技大學水產養殖系
吳慈芳、葉若蓼	2020中華林產事業協會學術論文暨研究成果研討會	遊客對台北植物園內氣味察覺之分析	中華林產事業協會 林業試驗所
王俊超、葉若蓼、徐健國 郭霽慶	2020中華林產事業協會學術論文暨研究成果研討會	澱粉改質及其應用於防油紙之研究	中華林產事業協會 林業試驗所
吳孟玲	2020都市樹木健康檢查與風險管理論壇	都市林樹木健檢與風險管理	林業試驗所
鐘詩文	台灣植物分類的時光之旅—植物標本館和植物園	百年榮光—林業試驗標本館(TAIF)的過去、現在與未來	台灣植物分類學會
何振隆、徐光平、何彗彤 蘇裕昌	2020中華林產事業協會學術論文暨研究成果研討會	多種樹種精油微膠囊之製備及其在芳香紙應用之探討	中華林產事業協會 林業試驗所
何振隆、徐光平、何彗彤 蘇裕昌	2020中華林產事業協會學術論文暨研究成果研討會	以近紅外線光譜分析技術(NIR)應用於漿料化學組成之探討	中華林產事業協會 林業試驗所
許錦漢、林志憲、李志璇 楊德新	2020中華林產事業協會學術論文暨研究成果研討會	台灣杉製材與結構用合板複合集成板之性質	國立中興大學 林業試驗所
陳佑安、趙偉成、李志璇 楊德新	2020中華林產事業協會學術論文暨研究成果研討會	巒大杉之製材利用率分析與材質評估	國立中興大學 林業試驗所
顧文君、林柏亨、林振榮 李鎧彤、傅春旭	2020中華林產事業協會學術論文研討會	本土栽植瑞香科植物不同部位抽出物之研究	中華林產事業協會 林業試驗所
林振榮、李志璇、塗三賢	2020中華林產事業協會學術論文研討會	應力波2D影像檢測法應用於四種樹木健全性的調查	中華林產事業協會 林業試驗所

研討會報告

作者	研討會名稱	論文題目	主辦單位
林振榮、塗三賢、李志璇 廖和順、林文星	2020中華林產事業協會學術論文暨研究成果研討會	系統家具塑合板廢料作為木藝再應用科普範例	中華林產事業協會 林業試驗所
塗三賢、劉慧玲	2020中華林產事業協會學術論文暨研究成果研討會	自製竹質複合3D列印線材的開發及性質分析	中華林產事業協會
蔡宇平、徐孟豪、吳孟玲 張俊彥	第十八屆造園景觀學術研討會	利用Google街景評估都市自然之健康效益	台灣造園景觀學會
呂明倫、黃靜宜、林依靜 趙家慧、葉文琪、陸聲山 宋一鑫	2020第31屆動物行為與生態學研討會	利用物種分布模式建構外來入侵害蟲之擴散預測—以雙色虎頭蜂為例	國立澎湖科技大學
余品臻、田謹萱、林依靜 陸聲山、村尾竜起 宋一鑫	2020第31屆動物行為與生態學研討會	黃跗虎頭蜂與黑腹虎頭蜂之巢篡現象初探	國立澎湖科技大學
李政昕、許富蘭、李鴻麟	2020中華林產事業協會學術論文暨研究成果研討會	台灣原生柑橘南庄橙果皮精油成分分析	中華林產事業協會

其他推廣刊物

作者	題目	書名期刊	卷(期) 頁碼、審查編號
徐光平	紙繡風華 格拉辛紙再次遇見紙繡	林產工業	24(3): 51-52
吳維修	臺北植物園2021年假日主題導覽方舟計畫 與野共生系列活動一同認識身邊的原生與稀有植物	台灣新論 教育廣播電台	2020/12/30
林文智	「衝！衝！衝！~林業經營加把勁，國產材自給率往前衝」		2
張心怡、吳憶萍、林文智 黃姝妍、倪筱婷	臺灣山茶六龜飄香		80
張育誠、謝宗宇、吳泰維 林德恩、黃志堅	身披甲冑穿山行旅—透過精選影像認識臺灣穿山甲	臺灣博物季刊	148期 92-99頁
陳筠、黃曜謀	東方莢果蕨之發現緣起與保育	台灣林業	46(4): 57-64
林俊成、徐韻茹	日本、韓國木材合法法案內容與推動進程	台灣林業	46(4): 47-56
范義彬、朱榮三、李政賢 陳永修	扇平森林生態科學園白天活動蛾類	林業推廣摺頁	推廣摺頁第163號
林俊成、王培蓉、徐韻如	國家森林部門及企業對實踐永續發展目標之行動指引	台灣林業	46(4): 37-46
傅淑瑋	為都市增添一抹綠，林業試驗所與國立臺灣圖書館、中和區公所及新中和社區大學合辦「韌性都市林示範區灌叢生態化活動」	新聞稿	2020年11月27日
傅淑瑋	透過垂直層次的植物栽植，增加都市林之綠色韌性	新聞稿	2020年4月10日
傅淑瑋	就是要韌性，打造一個在地的韌性都市林	新聞稿	2020年2月15日
傅淑瑋	建構韌性都市林，林業試驗所與國立台灣圖書館、中和區公所簽署MOU	新聞稿	2020年7月8日
徐健國	110林業試驗所手工紙月曆		110
林秀燊、施欣慧、林清山 李春燕、黃玉如	茶枝小蠹對茶樹的危害	茶業專訊	113: 13-14

其他推廣刊物

作者	題目	書名期刊	卷(期) 頁碼、審查編號
吳家禎	「純」才敢大聲!!牛樟到底純不純？林試所以基因解序找出珍貴牛樟雜交的證據	新聞稿	2020年11月18日
李俊緯	在思源埡口邂逅黃花鳳仙花	蘭陽博物館電子報	123期
徐嘉君、王驥魁、李崇誠	尋找深山巨木的人：用空載光達繪製台灣的巨木地圖	空間數位生活	1: 46-55
徐嘉君	蒸氣森林：鴛鴦湖保護區	法務部清流雜誌	27: 72-75
徐嘉君、陳建文、林謙佑	棲蘭山區附生植物的分布型式與特色		27(3): 62-65
徐中芃	大屯山公園設計概要	台灣學通訊	119期
劉宇軒、王相華	都市林下好乘涼	工商時報	
李俊緯、周穎宗、徐霈馨 劉盈孜、董景生、李柏宏	森林療癒了誰？里山社區的行動參與	林業叢刊	296號
李俊緯	蘭陽山區湖泊的水中精靈—東亞三稜	蘭陽博物館電子報	122期
李俊緯	金秋十月，龍爪花綻	蘭陽博物館電子報	122期
李俊緯	鼠去牛來辭舊歲、牛轉乾坤行大運—牛年生肖植物選介	動物園雜誌	161期
徐光平、何振隆	紙繡風華—格拉辛紙再次遇見紙繡特展	國立教育廣播電台、自立晚報、PChome新聞、農學報導、漁業廣播電台、八方新聞、新浪休閒等	2020年10月
徐光平	以清潔生產之常壓蒸煮技術製備竹漿		2020年8月
徐光平	COVID未來式，報你知~天然防疫，森(身)心療癒	工商時報、蘋果即時新聞、中央通訊社、中央廣播電台、中廣新聞網、台灣醒報等	2020年8月
陳盈如、陳舜英	療癒森呼吸		2020年6月
徐孟豪、蔡宇平、汪澤宏 吳孟玲	氣候及光週期對荔枝椿象成蟲族群動態之影響	林業叢刊	第295號

其他推廣刊物

作者	題目	書名期刊	卷(期) 頁碼、審查編號
賴政徽	40年臺灣杉試驗林首度疏伐 林試所：撫育林木、提高木材自給率	農傳媒	2020年8月13日
汪澤宏	樹木害蟲基因大解密	台灣時報等八家	2020年10月
陳舜英	悠遊蓮華池山林的新選擇～林園療癒	新聞稿：新頭殼newtalk/林業試驗所官網	
林建融	近百年的分類接力，鹿野氏馬蘭終正名！	新聞稿	2020年6月22日
李俊緯、董景生	林試所出版《椰子的葉蔭》新書談百年前的博物學家川上瀧彌的南洋探險記	新聞稿	2020年7月17日
李俊緯	夏夜河畔的閃亮煙火—水茄苳	蘭陽博物館電子報	120期
李俊緯	從繁盛到瀕絕—守護宜蘭溝渠濕地的水岸明珠「風箱樹」	蘭陽博物館電子報	119期
李俊緯	宜蘭山區湖泊限定的天賜珍饈—蕅	蘭陽博物館電子報	118期
李俊緯	思源埡口的閃亮明星—宜蘭天南星	蘭陽博物館電子報	117期
李俊緯	「蕨」滅危機—在地珍稀宜蘭禾葉蕨	蘭陽博物館電子報	116期
李俊緯	最帶種的宜蘭原生蕉—噶瑪蘭芭蕉	蘭陽博物館電子報	115期
游漢明、鍾振德	2020森林資源保存與利用研討會論文集	林業叢刊	第294號
曾俊偉、王秋嫻	2020森林集水區及環境監測研討會論文集	林業叢刊	第293號
謝靜敏	油茶種實採收有撇步 榨油品質獲國際認證	新聞稿	2020年9月10日
江汶錦、吳有恒、吳羽婷 吳耿東、李宜映、林文風 林裕仁、邱祈榮、倪禮豐 徐英綺、張敬宜、張廖伯勳 梁瑩如、陳韋辰、陳琦玲 陳鴻堂、黃文益、楊蔚因 劉俊宏、蔡正賢、鄭美如 龍暐、薛佑光、簡士濠	臺灣生物炭產製與農業應用指南	林業叢刊	第291號
洪州玄、范義彬、潘東波	恆春半島的海濱及礁岩植物—草本篇	林業推廣摺頁	推廣摺頁第162號

其他推廣刊物

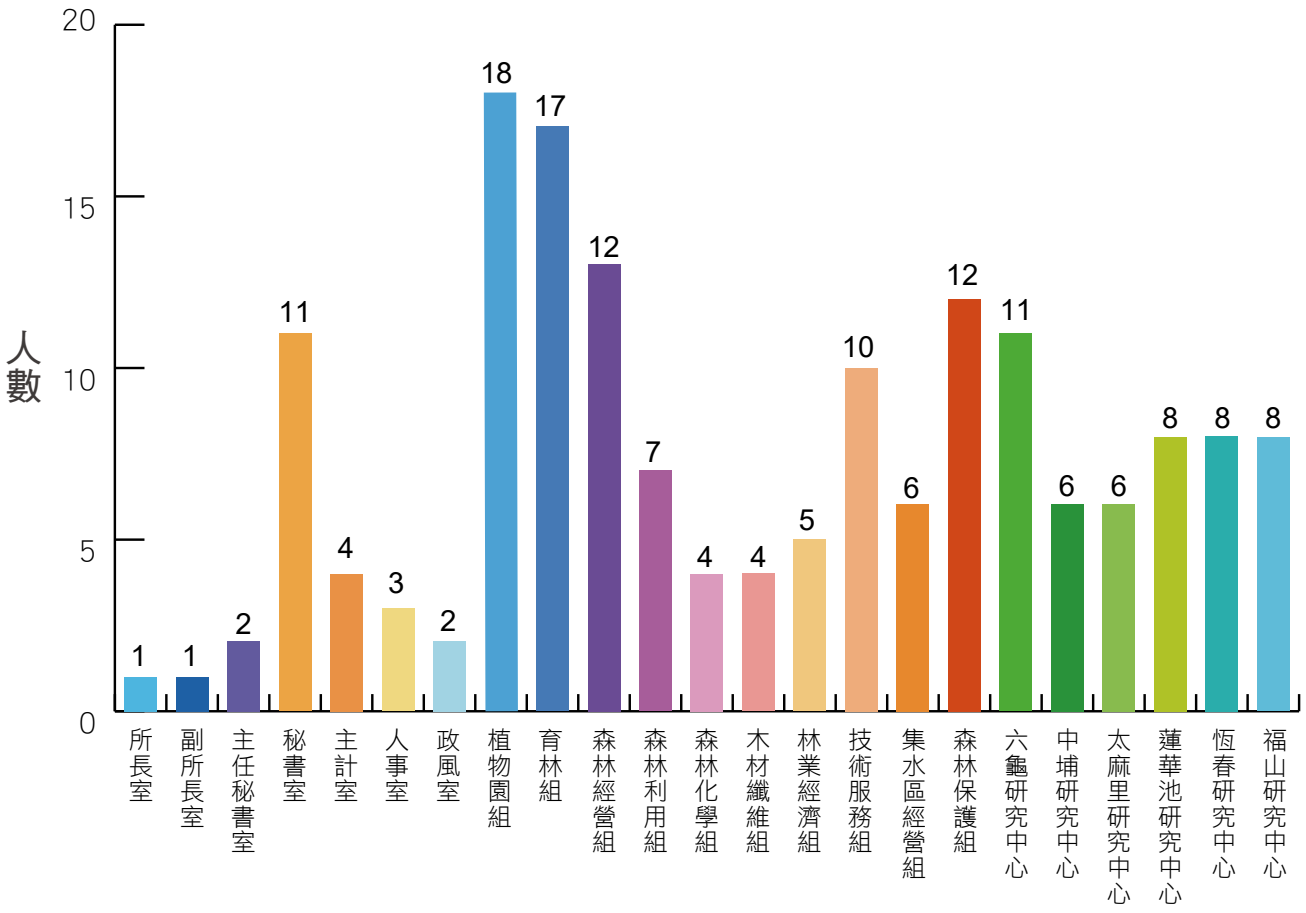
作者	題目	書名期刊	卷(期) 頁碼、審查編號
范義彬、朱榮三、李政賢 陳永修	扇平森林生態科學園賞蝶圖鑑	林業推廣摺頁	推廣摺頁第161號
林柏亨、林振榮、顧文君	木本油料植物新用途 瓊崖海棠油作紫外線屏蔽劑	中時新聞	2020年8月27日
徐孟豪、汪澤宏、吳孟玲 吳怡慧、蔡宇平	非農業區裡的荔枝椿象(龍眼篇)	林業推廣摺頁	推廣摺頁第158號
吳孟珊	「森林生態系服務」重要性排名出爐 水土保持榮登榜首！	新聞稿	
王巧萍	向下紮根，用戲劇把土壤救回來	新聞稿	
黃俊元	「拔新領異覓得法、胸懷所及乃自佳」—海岸直播造林新技術	新聞稿	
陳建帆	臺北植物園腊葉館榮獲第一屆臺北市文資保存維護譽揚獎	中天、中時新聞、 PChome新聞	2020年7月
胡元瑋、黃俊元、李銘鐘 楊蒼叡、賴政徽	太陽照耀的肥沃土地—太麻里	林業叢刊	第290號
王韻皓	看見森林 向測量前輩致敬 「森林 x 現代性—航遙測影像下的科學敘事」特展開幕	環境資訊中心	
黃雅玲、伍淑惠	認識台灣原生秋海棠之美—蘭嶼秋海棠繁殖與栽培	園藝之友	200
詹為巽	林試所調查！都市居民最在乎樹木調節氣候功能	新聞稿	
何政坤、許原瑞	推動林下經濟的推動與發展	台灣林業	46(2): 13-22
陳芬蕙、何政坤	林下經濟開放品項淺談	台灣林業	46(2): 23-30
李隆恩	山村地區脆弱度研究解讀 預警風險區域 預做因應減少災害損失	新聞稿：台灣英文新聞、PChome新聞	
吳孟玲、徐孟豪、劉則言	樹木褐根病診斷及防治建議手冊		2020年1月25日
董景生	偏書評 游旨价(通往世界的植物，台灣高山植物的時空旅史)	聯合文學	第427號

其他推廣刊物

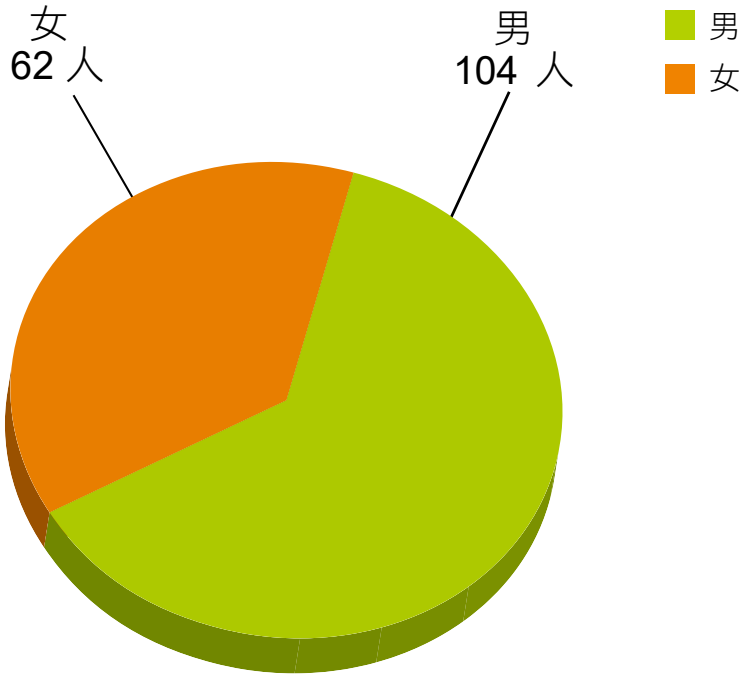
作者	題目	書名期刊	卷(期) 頁碼、審查編號
何振隆、徐光平	TATM技術快訊：【常壓蒸煮製備竹漿技術】	農業技術交易網(TATM)	第220期
駱傳華、何振隆、徐光平 徐健國、沈匀嘉	紙繡風華—格拉辛紙再次遇見紙繡特展	林業推廣摺頁	推廣摺頁第159號
鍾振德、蔡佳彬、馬復京 游漢明	桉樹、相思樹、楓香、杜英優良品系之育苗體系	林業推廣摺頁	推廣摺頁第157號
董景生	從癮台灣談政府科普出版品	臺灣出版與閱讀	109年第1期
傅春旭、張東柱、黃勁暉 李鎧彤、張詠怡	台灣松露之研究近況與技術開發	農政與農情	333: 113-117
吳家禎、何政坤	癒見醇香土肉桂	影音專區	5分10秒
黃曜謀、陳正為	發蕨	影音專區	4分50秒
范義彬、劉一新、陸聲山	福山試驗林常見大型蛾類	林業推廣摺頁	推廣摺頁第160號
康碩容、吳家禎、黃曜謀	「癒見醇香土肉桂」、「發蕨」—林試所技術影片正式上線	新聞稿	2020年1月22日
范義彬	2020年林業試驗所「林業研究加值再利用文創品」	101新聞網	2020年2月15日
吳維修	臺北植物園2020年假日主題導覽「植物放大鏡」系列活動帶大家仔細瞧，瞧仔細！	農傳媒、今日新聞	2020年1月

人力資源

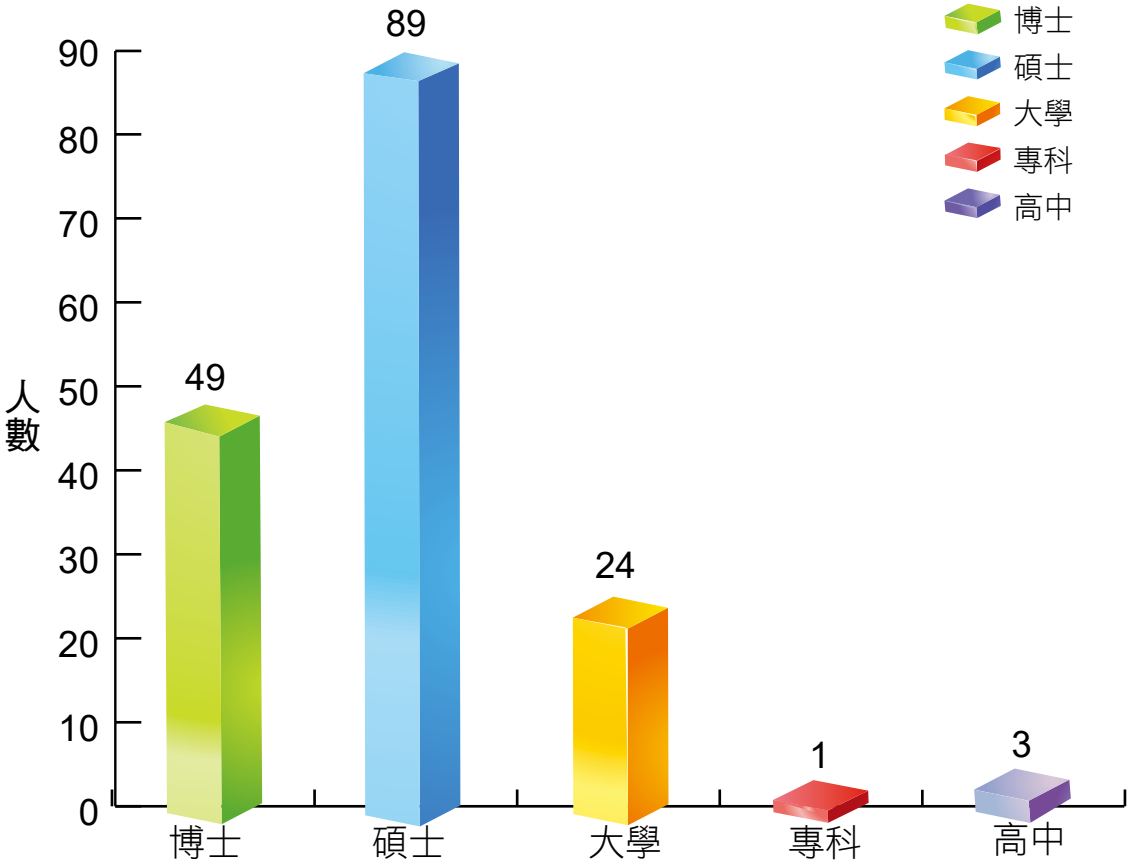
組、室、研究中心共計166人



男女人數


女
62 人
男
104 人
男
女

教育程度

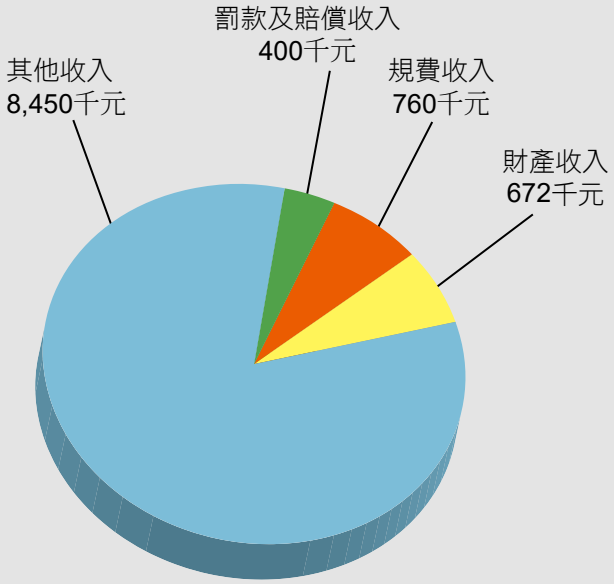

博士
碩士
大學
專科
高中
人數
90
80
70
60
50
40
30
20
10
0
49
89
24
1
3
博士
碩士
大學
專科
高中

財務預決算

(一)109年度預算

1.歲入：本年度歲入預算數10,282千元，較上年度10,582千元減列300千元，其主要內容如圖1。

2.歲出：本年度歲出預算數799,933千元，較上年度720,661千元增列79,272千元，其主要內容如圖2。

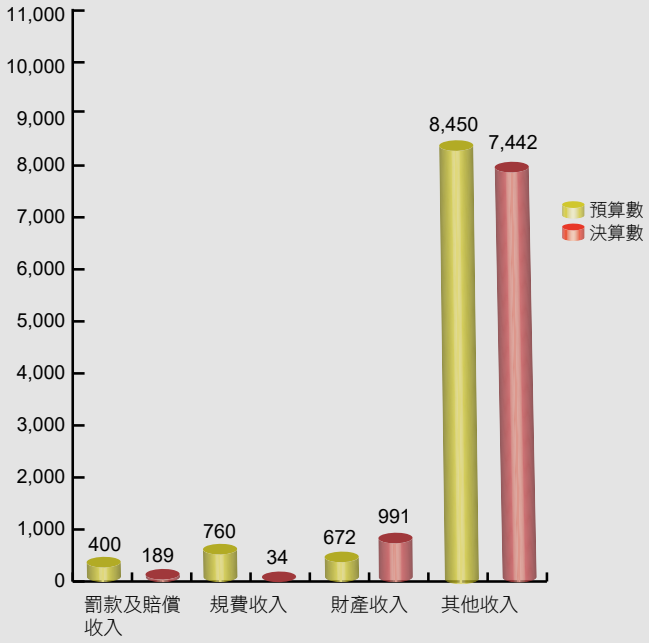


▲ 圖1. 109年度歲入預算主要內容（單位：千元）

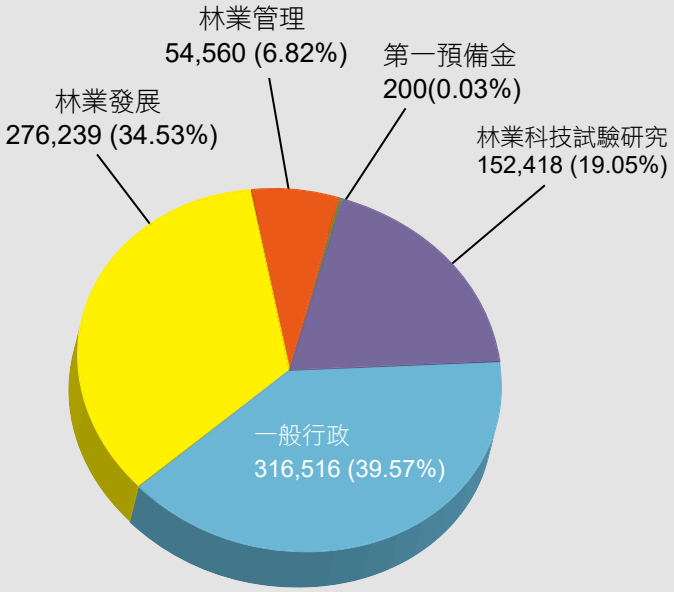
(二)109年度決算

1.歲入：本年度歲入預算10,282千元，決算8,656千元，執行率84.19%，其主要內容如圖3。

2.歲出：本年度預算數799,933千元，決算數781,167千元，執行率97.65%，其主要內容如圖4。



▲ 圖3. 109年度歲入預算執行情形（單位：千元）



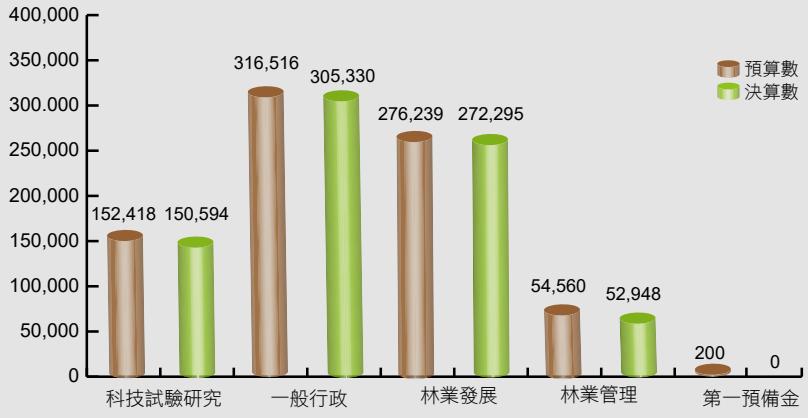
▲ 圖2. 109年度歲出預算主要內容（單位：千元）

(三)109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14,809千元，執行數11,669千元，執行率78.8%。

(四)109年度代辦計畫經費

本年度辦理代辦計畫經費37,322千元，執行數29,421千元，執行率78.83%。



▲ 圖4. 109年度歲出預算執行情形（單位：千元）

2020 Annual Report

行政院農業委員會
林業試驗所一〇九年度年報

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