



CHINESE ACADEMY OF FORESTRY

VISION

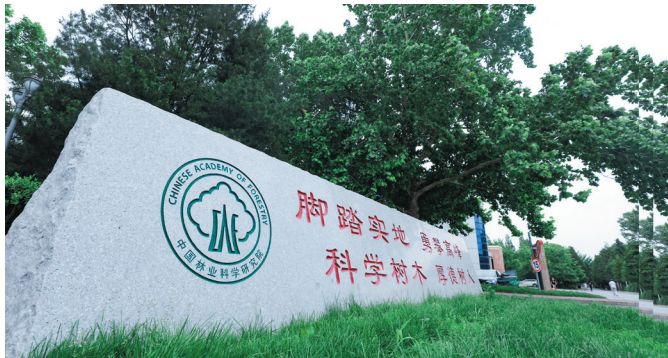
As the national institution for research in relation to forests, forest industry and grassland, CAF's vision is to interlink scientific research findings, production practices and policy and decision-making for the sustainable development of China's forest sector and the materialization of ecological civilization.

MISSION

CAF is a multi-disciplinary and non-profit research and education organization engaged in both basic and applied sciences, technologic research and development and forest-related social science. It is devoted to providing research findings and knowledge to advance forestry growth, improve ecological environment, safeguard eco-security and boost ecological civilization.

MOTTO

Truth, ambition, wisdom and integrity.



STAFF

Total permanent staff: 3,218
Research fellows: 2,075
Professors: 270
Associate professors: 690
Assistant professors: 800
PhD holders: 977

RESEARCH FACILITIES

CAF has published over 20,000 academic papers and 900 books and obtained 1,502 issued patents with support from following facilities:

- 6,667 ha experimental forests;

- 1 national lab of excellence on forest tree genetics and breeding, 1 national engineering lab and 19 provincial or sectoral-level labs;
- 39 field stations of terrestrial ecosystem research.;
- 19 engineering technology research centers;
- 6 sectoral-level nature reserves;
- 10 national forest tree germplasm banks;
- 3 national nurseries; and
- one of the largest database of forest research literature in Asia.



GRADUATE EDUCATION

CAF's Graduate School was established in 2002 in partnership with the International Center for Bamboo and Rattan (ICBR). Now CAF has 161 PhD supervisors and 229 master supervisors and more than 1,300 students are studying at CAF. CAF has totally recruited 5,379 students of various degrees/programs by 2018, including:

- 1,762 PhD candidates;
- 2,369 master candidates of scientific degree;
- 631 master candidates of agricultural extension;
- 534 master candidates of landscape architecture.





CHINESE ACADEMY OF FORESTRY

FROM LAB TO FARM TECHNICAL EXTENSION

A series of effective measures have been adopted by CAF for the application and extension of its research findings and developed technologies:

- Joint establishment of provincial-level branch academies and other research facilities;
- Demonstration sites of fast-growing and high-yield forests;
- S&T field service teams composed of CAF scientists and technicians; and
- Provision of trainings and consultancy.

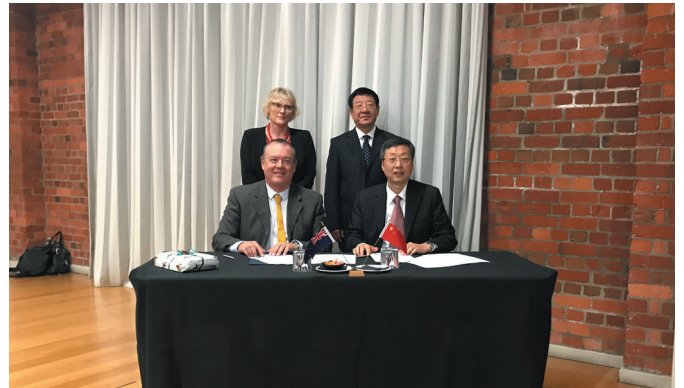


INTERNATIONAL COOPERATION

- Cooperation and exchange with more than 80 countries and over 50 international organizations;
- Over 90 MOUs signed with partners in 28 countries and nearly 10 international organizations;
- A long-standing member organization of IUFRO, and host of its first Regional Congress in Asia and Oceania in 2016;
- Contribution to the establishment of the first

intergovernmental organization based in China – International Bamboo and Rattan Organization founded in 1997; and

- Completed nearly 600 international projects studying on including but not limited to the application of remote sensing in managing forest resources, sustainable management of tropical forests, wood science, forest genetics, wildlife conservation, bamboo research, tree physiology and pathology, desertification, etc.





RESEARCH FIELDS OF EXCELLENCE

FOREST ECOLOGY AND ENVIRONMENT

Remarkable research progresses have been made in production ecology of plantations and forests, forest ecological engineering, shelterbelts, forest ecosystem observation, etc.

Natural forest protection and ecological restoration

CAF's study on natural forest protection and ecological restoration has conquered the core technologies in natural dynamic disturbances and conservation, restoration of typical degraded natural forests, landscape restoration and spatial management, etc., and presented a model of restoring degraded natural forests. In addition, eco-friendly harvest technology considering both the common technical standards and the appropriate technical mode for specific forest types was developed for logging and regenerating natural forests in northeast China.



Regeneration by forest gap regulation and forest ecological tending operation in the mixed forests of deciduous broadleaved tree and Korean pine in northeast China

CAF is equipped with 39 field stations of terrestrial ecosystem research. A national ecosystem observatory network has been established. The long-term observation and research of tropical forest ecosystems in Jianfengling of Hainan island, for the first time, disclosed the flow rules of water, nutrients and energy in tropical forests and clarified the structure, function

and way of sustainable development of tropical forest ecosystems.



Distribution of CAF's Ecosystem Research Stations

The long-term research of complex ecosystems in agricultural areas in Huanghuaihai Plain made breakthroughs in species disposition in ecosystems, exploitation of potential niches, water ecological characteristics, light utilization, etc., and provided a multi-species, multi-layer and multi-benefit agro-forestry model with spatial-temporal sequences, which helped increase the efficiencies of light and water utilization by 12% respectively and add agricultural yields by 18%, resulting in 28% extra benefits in comparison to ordinary farms.



Efficient shelterbelt system in the Three Gorges area



RESEARCH FIELDS OF EXCELLENCE

Afforestation technology

Site-appropriate and species-appropriate afforestation technology developed by CAF works well for the water and soil conservation in rocky hills of Taihang Mountain. Enclosed forest cultivation and artificial regeneration was applied against the rocky desertification in south China and underpinned the ecological rehabilitation of local Karst areas. Domestication and afforestation technology of mangrove species was studied and applied in coastal shoals in south China. CAF has been studying on developing a state-appropriate forest ecosystem network to meet with the eco-security needs of national and local forest ecological program and has started pilots in 22 provinces and autonomous regions.



Afforestation in rocky hills of Taihang Mountain



Afforestation in rocky desertification areas in south China

Forest ecology application

The scope of applying CAF's forest ecology research has been widened overtime. A national ecosystem observatory network has been established through its monitoring and evaluation of forest ecosystem functions, and the Criteria & Indicators of observation and assessment of China's forest ecosystem services and functions have been provided. The NSFC project "China Forest Ecosystem Structure and Functioning Logic" completed by CAF initiated the application of long-term forest ecosystem observation to conduct the networking of inter-disciplinary ecosystem research. Outcomes generated by CAF's ecosystem research include but not limited to the identified geographical distribution of China's diverse forest ecosystems and their composition of communities, productivity, nutrient cycles, eco-hydrology and energy use, the spatial variation of forest carbon stocks in China, the impacts of climate change on woody plants, methodology of carbon accounting and monitoring, the coupling mechanism of eco-hydrological processes, conservation of forest biodiversity, wetlands, birds and wildlife, etc.



Ruo'ergai alpine wetland in Sichuan Province

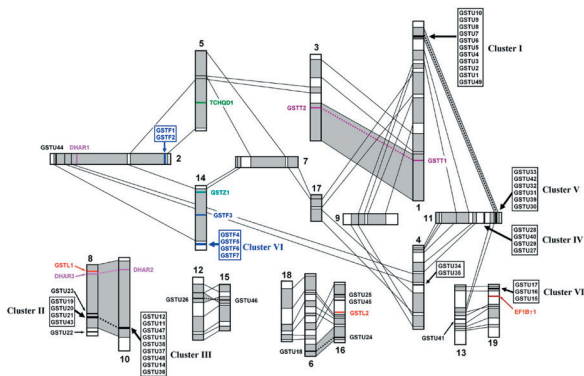




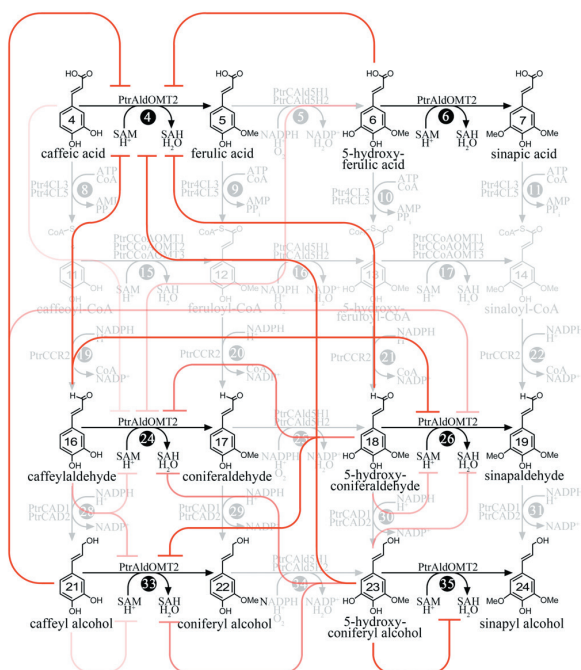
RESEARCH FIELDS OF EXCELLENCE

TREE GENETIC IMPROVEMENT

For six decades, CAF has successively studied on the genetic improvement of *Populus*, *Cunninghamia lanceolata*, *Larix dahurica*, *Pinus massoniana*, paulownia, eucalyptus, acacia, *Hippophae rhamnoides*, *Juglans*, *Camelia oleifera* and etc., and successfully provided many new superior varieties (clones/ families), which have been applied extensively in forestry construction. In particular, our research on *Populus* genetics has generated comprehensive products both theoretically and practically and shifted from pure traditional methods to the combination of molecular biology.



Genome structure of GST gene family of poplar



Model establishment and prediction of lignin synthesis of poplar

Improved varieties selecting and breeding

Research on the geographical variation and provenance analysis has been conducted for *Cunninghamia lanceolata*, *Larix dahurica*, *Pinus massoniana*, *Pinus tabuliformis*, *Ulmus pumila*, *Platycladus orientalis*, *Pinus armandii* and other species. The mountainous area in Nanling has been identified as the ideal provenance zone of *Cunninghamia lanceolata* and many locally-sourced provenances have been selected, which prove to obtain a 20%+ increase in their timber yield. Roughly 20 species of *Ulmus pumila*, which can grow in different regions and increase timber yield by 10-20%, were selected. Such findings provided scientific evidence for the reallocation of seeds. Techniques have been set forth for establishing seed orchard of advanced lines of *Cunninghamia lanceolata*, where 143 superior families and over 400 fine clones have been selected, increasing the timber production by 15-217.2%, and they have been extensively used in Hunan, Jiangxi, Guizhou, Guangdong, etc. The difficulties in producing new hybrids and cutting propagation of coniferous trees like *Larix dahurica* and *Pinus massoniana* have been overcome, and 38 fine clones and 30 new hybrids of *Larix* were invented and more than 70 families and hybrids of *Pinus* were created.



Cunninghamia lanceolata clones test plantation



RESEARCH FIELDS OF EXCELLENCE



Seed orchard of second generation clones of *Pinus massoniana*

35 fast-growing and high-resistant clones of broadleaved species like populus and paulownia were cultivated through artificial hybridization and selection. Various superior poplar varieties with high resilience, fast growth and good timber were selected in 1950s'-1960s' and they have been planted in northern, northeastern and northwestern China. 12 new poplar varieties were selected, for instance, Zhonglin 46 can have an increase of 30-50% in timber yield and it has been used in 634,000 ha of plantations. The selected paulownia varieties, C020, C125 and Maobai No. 33 can even have an increase of 70% in their timber yield. Populus 107 & 108, clones of *Populus nigra*, have been applied in plantations of more than 1.33 million ha, which are mostly in north China, and helped increase the annual timber production by nearly 30 million m³. Cold-tolerant eucalypt varieties and high-yield and pest-resistant poplar varieties were developed through genetic improvement.



Transgenic-resistant Poplar No.1

Non-timber tree and shrub breeding and cultivation

16 early-bearing, high-yield and resilient walnut varieties were selected in 1990s and were planted in Shanxi and Henan, achieving an average yield of three tons of walnuts per hectare. Superior varieties selection studies are also conducted on *Camellia oleifera*, olive, *Eucommia ulmoides*, *Hippophae rhamnoides*, *Xanthoceras sorbifolium*, etc.



Walnut 'Jinfeng' with Fruits



Camellia oleifera 'Changlin No.40'



Hippophae rhamnoides 'Shalin No.9' (Nonthorny big fruit seabuckthorn)

Germplasm conservation

CAF has established 11 germplasm conservation banks, 13 site banks, 4 extended banks and 1 low-temperature bank, and they are conserving 256 species and 50,696 germplasms.



RESEARCH FIELDS OF EXCELLENCE

SILVICULTURE

Silviculture technologies

Through carrying out comprehensive surveys on the natural forests of *Abies fabri*, *Pinus yunnanensis* and *Larix dahurica* in southwestern and northeastern China, CAF scientists have clarified their composition, structures, growth, forest types and regeneration rules and provided plans for their management, harvest and regeneration. Long-term study was conducted on the cultivation, and amelioration of secondary forests in the north and enclosed conservation methods were adopted. Aerial seeding for certain species was studied and applied in an area of more than 8 million ha.



Afforestation by aerial seeding

Seed zones of prior species were identified and method of testing forest seeds was formulated. Technology ensuring survival of *Pinus massoniana*, *Larix kaempferi* and *Liriodendron chinensis* cuttings was developed. Mycorrhizal inoculation technology was developed for various species under different propagation methods. Light substrate bags were invented for seedling propagation using eucalypt twigs. CAF established China Forest Site Categorization and Evaluation System for timber plantations across the country and its forest soil study generated significant progress. Optimized models for cultivating timber for construction materials and paper pulp from *Cunninghamia lanceolata*, populus, *Pinus massoniana*, *Pinus elliottii* and larch were provided. A low-density system in favor of target trees for medium and large-diameter fir wood was

established, and in its experimental forests, the stand growth increased by 14.1%, the proportion of quality large-diameter wood increased by 30% and the rotation debased two years. CAF's cultivation techniques for fine quality and high-yielding *Pinus elliottii* and larch enables the stand growth to increase by 13.8% on average. Silvicultural techniques have been developed for fast-growing and high-yielding *Eucalyptus Urophylla*, *E. Grandis* x *E. Urophylla*, *E. Saligana*, and the annual increment of 4-year plantations of *E. Urophylla* reaches 35 m³/hm², *E. Grandis* x *E. Urophylla* 37.3 m³/hm² and *E. Saligana* 27.4 m³/hm². 60 quality species for fuelwood were selected and a national planning of fuelwood forests and their management was provided. Cultivation technology for large-diameter eucalypt, acacia and *Betula* was advanced and mixed plantation of eucalypt and acacia was built.



Light substrate bags for seedling propagation



RESEARCH FIELDS OF EXCELLENCE

Bamboo cultivation

CAF has carried out productive long-term research on bamboo germplasm collection, plantation establishment, fertilizer, etc. Pulp bamboo forests of *Phyllostachys* were cultivated and the annual bamboo production reaches 22.45 tons/ha. High-yield plantations for both bamboo shoots and bamboo were successfully established. A water-conserving irrigation system for bamboo forests was created by using stumps to keep water and applying the catchment method. Oriented cultivation technology of short-rotation *Phyllostachys* plantations for large-diameter wood was planned and piloted in 7 demonstration sites, covering an area of 1,532 ha.

Plant growth regulators

ABT Powdered Rooting Hormone has helped successfully produce environment-friendly complex hormone for plant growth, which can improve the plant quality, production and resistance. It has been applied in 80% of China's cities and counties and in 1,582 plant species, covering an area of more than

10 million ha and growing 5.931 billion seedlings. In addition, CAF's rattan research has established the most developed rattan specimen repository in China and collected the most rattan genes in the world. We discovered that rattan contains four genera and 14 species of VA mycorrhizal fungi, which can facilitate the growth of rattan seedlings. CAF also made progresses in cultivation technology of valuable species, such as teak, *Betula*, *Dalbergia odorifera*, etc.



Interplanting rattans under crown of plantations





RESEARCH FIELDS OF EXCELLENCE

DESERTIFICATION

For six decades, we have obtained a series of research findings in desert categories, selection and breeding of psammophytes species, sand-fix infrastructure, desertification monitoring and evaluation, occurrence rule of desertification and integrated desertification control.

Combating desertification

Sand-fixing plantations have been experimented in Yulin since 1950s' and seven site-appropriate bush species were selected. The study of site classification of Mu Us sandy area was started in 1980s' and research results included a formulated quantitative table of its site quality and an approach combining grassland, forestry and agriculture ecosystems with emphasis on bushes, which was applied extensively in Mu Us and helped increase plant survival by 15%. A shelterbelt network has been built in Ulan Buh Desert, establishing a man-made oasis of 1,486 ha. Quantitative indicators were developed against the environmental quality improved by large-scale greening programs, which proved that shelterbelts could effectively mitigate the atmospheric evaporation by 30-40%, alter the wind-drift sand flow, and thus reduce the hazards brought by sand storms. The decade-long study revealed the rule of desertification occurrence for the first time, selected 11 plant species for desertification control under extreme environmental conditions and established the control

approaches for four typical categories of desertification, which were demonstrated in a total area of over 6,700 ha.



Quicksand was fixed three years after afforestation by aerial seeding of *Astragalus adsurgens* and *Melilotus suaveolens* in Qishanboqu of Yulin



Shalin Reforestation Program



RESEARCH FIELDS OF EXCELLENCE

Desertification control techniques

A comprehensive survey of Kumtagh Desert has been completed by crossing the desert from south to north. An all-weather meteorological station has been set up in Kumtagh. Gravel moraine, the Kumtagh-specific landform was discovered and named for the first time and it was identified that Mingsha mountain of Dunhuang is an important component of Kumtagh Desert. Plants growing in China's main deserts were comprehensively surveyed and *Atlas of China Desert Plants* was published. A low-coverage sand-control approach was established, which found that vegetation coverage of 15-25% could fix the sand flows, and associated techniques and methods were developed. Interaction between forests and water in northwestern arid and semi-arid areas was studied and indicators against the bearing capacity of vegetation considering water resources and crucial technique in regulating moisture was developed.



Low-coverage and banding-collocating approach to control sand



Low-coverage and banding-collocating approach to control sand

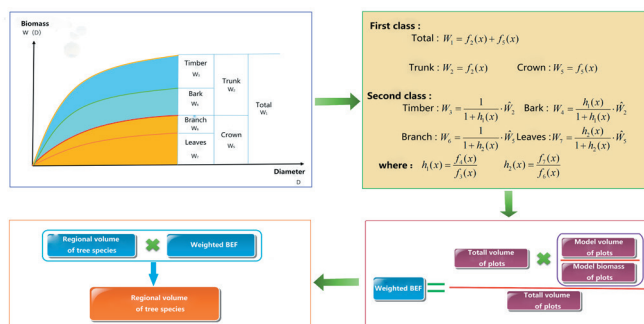


FOREST RESOURCES MANAGEMENT

The application of remote sensing in monitoring and managing forest resources was initiated in early 1980s', when CAF developed the software for processing RS data and used space RS data to map the forest distribution and stock volume estimation in Linjiang, Jilin. In a succession afterwards, terrestrial resource satellite TM, SAR, GIS, GPS were applied in forest resource management. Now CAF has established an integrated approach combining RS, GIS and GPS for monitoring forest resources, environment, disasters, etc.

Forest growth modelling

CAF plays a leading role in forest growth modelling, statistics and forest inventory technology. In terms of research on growth and management models and optimized control, the theory about the relationship between maximum density of forest stands and adaptive sparse was established and a thinning model was derived from the basis of growth model, which included the parameter estimation considering measurement error and could propose an optimized control of main logging while also conducting thinning. CAF's research on whole-stand modelling, coupling of three types of modelling and stand density and sectoral forest resource management has been proved to be world-leading.



Forest biomass model based on sample plots

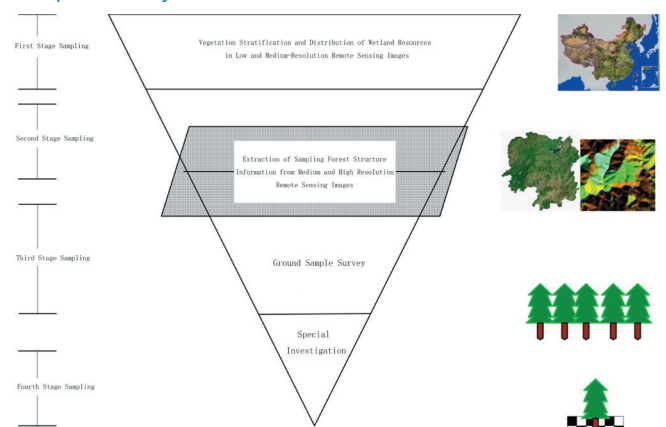
Forest management technology

A technologic model of forest management based on three feedback loops was proposed in the research of modern management technology for timber plantations in south China. The conceptual framework

of structural forest management was explored, with quantitative analytic method of forest spatial structure developed and stand structure parameter system created, which realized the application of spatial structure research findings in guiding the restructure of forest stands. Technical research was carried out on forest management aiming at developing multi-functional planted forests, with principles and indicators of multi-functional forest management and a technical sub-system for forest management planning were developed. Research on forest growth simulation modelling was conducted and the whole-forest growth modelling method was applied in management practices. In combination with its pilot project in support of the Natural Forest Protection Program, CAF established a close-to-nature forest management planning model.

RS technology

Significant achievements have been made in the development and application of space RS technology in integrated forest monitoring systems. An integrated and multi-scale forest resource monitoring system combining modern forestry information techniques and traditional land survey was developed. Multi-phase RS sampling was accomplished in term of RS data processing, analysis and application and a general software of forest inventory RS data was developed independently.



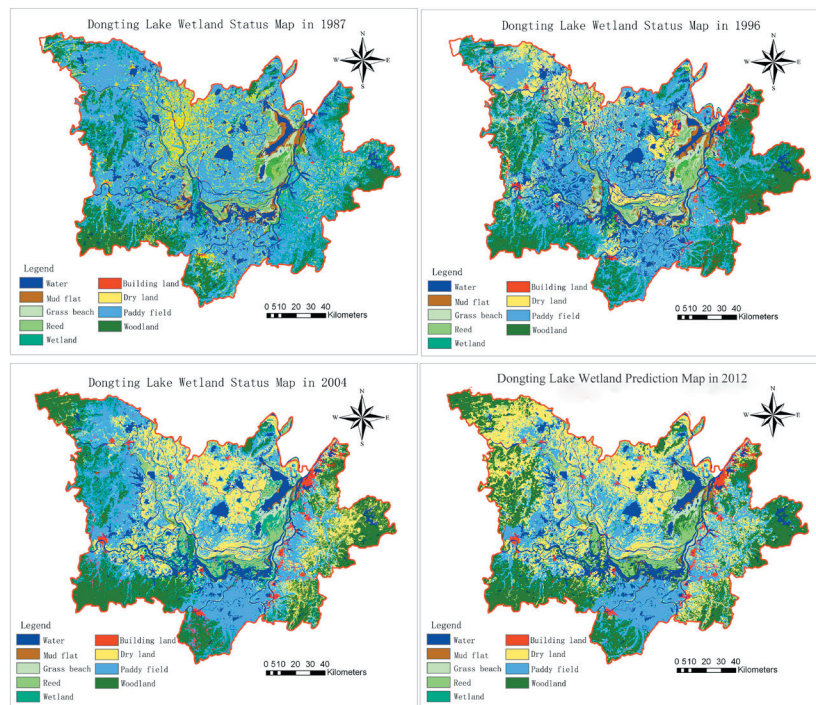
Integrated forest resources monitoring sampling system



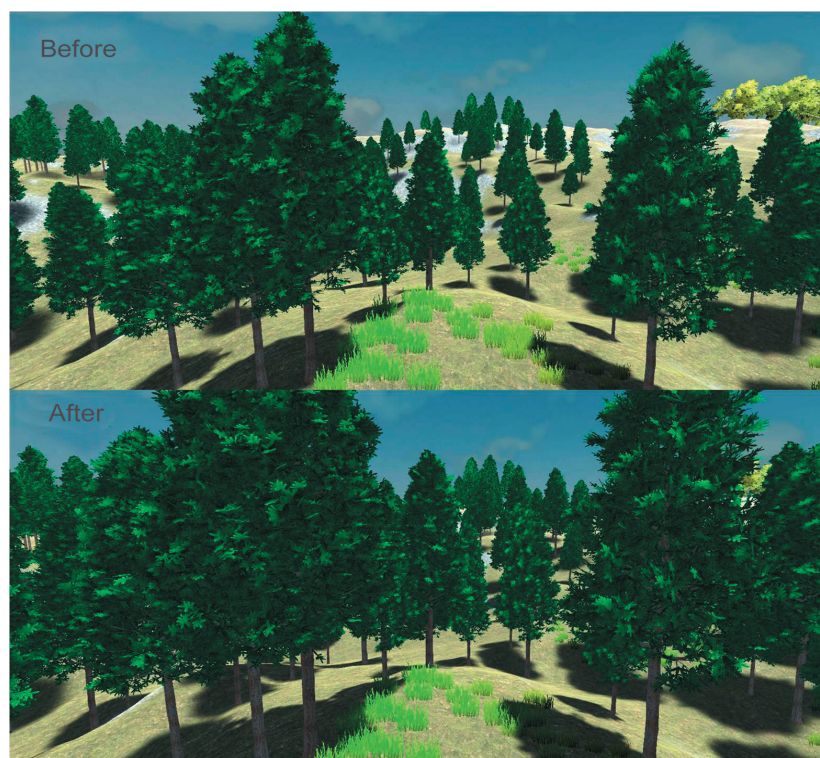
RESEARCH FIELDS OF EXCELLENCE

Based on high-performance computing environment and cloud calculation, a high-resolution RS application technology and service platform was established, breakthroughs in eight core technologies in applying high-resolution forest RS were overcome and five

categories of thematic databases were built. Supportive technology for forest management decision-making was advanced, including digital forest modelling and visualization, digital forest and pastureland management, etc.



Wetland dynamic monitoring and prediction simulation technology



Forest resource monitoring visualization system



RESEARCH FIELDS OF EXCELLENCE

FOREST PROTECTION

Numerous research findings and progresses have been obtained in forest protection against forest diseases, pests and forest fire and applied in practices.

Forest pest control

Technologies and systems have been developed in preventing and controlling *Dendrolimus* spp., bamboo locust, *Hippota dorsalis*, *Matsucoccus matsumurae*, pine shoot insects, *Saperda calcarata*, *Apocheima cinerarius*, *Dendroctonus valens*, *Hyphantria cunea*, *Gilpinia lipuensis*, pine wilt disease, poplar canker, paulownia witch's broom disease, bacterial wilt of eucalyptus and etc. A shift from individual target control into integrated and ecological control was accomplished. Microorganisms and natural enemies were studied with priority. CAF has invented the first Bt pesticide in China and continuously developed and applied highly virulent bacteria strains. Remote sensing and semiochemical approaches have been applied in monitoring the occurrences of pest disasters and the dynamics of targeted species. Long-term intensive research has been conducted for controlling *Dendrolimus* spp., identifying various typical zones of its occurrences, establishing serial forecasting and monitoring systems and applying integrated biological control which has been proved to be highly effective – the occurrences of *Dendrolimus* spp. in pilot areas were reduced by 90% or above. In particular, DCPV (*Dendrolimus* cytoplasmic polyhedrosis virus) is proved to work excellently in controlling *Dendrolimus* spp. Highly virulent nuclear polyhedrosis virus of *Apocheima cinerarius* has been obtained and new Aci-NPV technique has been developed, producing a 90%+ performance in in-forest application, where 1-year application can generate effects for 3-5 years. *Chouioia cunea*, an effective natural enemy of *Hyphantria cunea* was found for the first time. The release of *Chouioia cune* and HC-NPV (nuclear polyhedrosis virus) can decrease the infected trees to below 0.1% in the testing areas. Such method has been applied in 2/3 of the area prone to be affected by *Hyphantria*

cunea. The application of *Dastarcus helophoroides*, a parasite natural enemy insect of longicorn can reduce the longicorn population by 86%. Bamboo pests were studied and the biological characteristics and occurring rules of 48 bamboo pests were clarified. Based on their bio-ecological characteristics, bamboo pest control methods were applied in a total area of more than 6,7000 ha in 7 provinces and autonomous regions, showing an efficiency of 95% or above. The temporal sequence of dynamics of bamboo beetles has been disclosed and applicable food baits have been selected.



Larvas of *Dastarcus helophoroides* parasitizes longicorn



Dastarcus helophoroides Breeding

Genealogical classification and identification were carried out against some important pests, including sawflies, ants and nematodes, and a number of new genera and species of them have been published. CAF published the most complete monograph of



RESEARCH FIELDS OF EXCELLENCE

forest insects in China - *Forest Insects of China*, which introduced the morphology, biological characteristics and control methods of 824 forest insects. In recent years, the chemical-ecological control of *Dendroctonus valens* has been studied and obvious progress has been made.

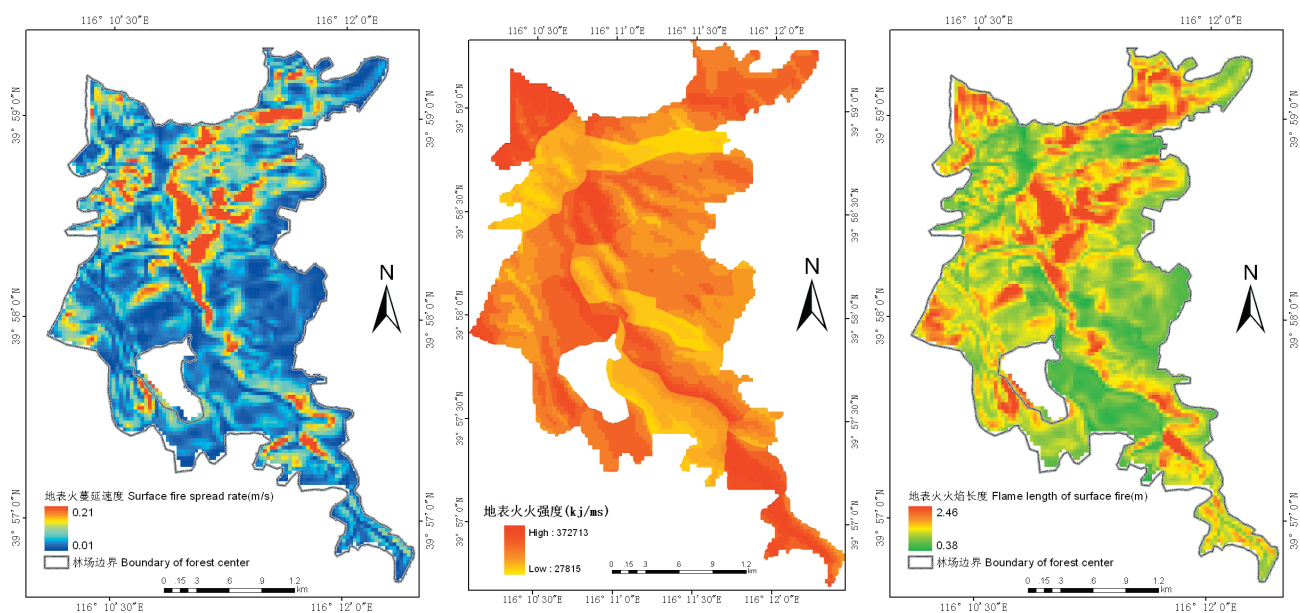
Forest disease control

In term of forest diseases, poplar species resistant to canker were selected and used in forest production. The technology in removing MLO pathogens of paulownia withes' broom disease using temperature treatment was created, which can achieve 100% detoxication. Early diagnosis methods of dangerous invasive diseases, such as pine wilt disease, have been developed and types of epidemic areas affected by pine wilt disease have been identified. These research findings have provided scientific evidence and methodologies for quarantining and detecting biological invasion.

Forest fire control

Breakthroughs were made in the fire resistance mechanism and establishment technology of green firebreaks. A database of fire-resistant tree species was established based on four categories of identification methods, i.e. determination, discriminant analysis,

clustering analysis and multi-target decision-making of indicators of fire-resistant species. The county-level emergency commanding systems of forest fire fighting, which integrates ground patrolling, public reporting, helicopter patrolling, satellite monitoring, etc., have been developed and applied. County-based early-warning systems are also developed and applied, with hierarchic early-alarming technology studied, which realizes spreading simulation and early-alarming for fire fighting under complex meteorological conditions, landforms and vegetation covers. Mechanism of fire starting and integrated control technology were studied and a database about occurrences and fighting of historically significant and severe fire disasters in the southwest and northeast was established.



A county-level emergency commanding system of forest fire prevention



RESEARCH FIELDS OF EXCELLENCE

WOOD SCIENCE AND WOOD PROCESSING & UTILIZATION

Extensive and productive research has been carried out, focusing on natural biomass-based materials, composites and synthetic materials. The properties of wood resources were evaluated and CAF released its research findings on wood properties of nearly 1,000 wood species. A series of research monographies exploring the relationship of wood properties and their cultivation and utilization have been published, including *Wood Identification*, *Technical Properties and Uses of Important Tree Species in China*, *Tropical and Subtropical Wood in China*, *Wood Records of China*, *Wood Science*, *Physical and Mechanical Wood Properties of Important Species in China*, *Wood Anatomy and Ultrastructure of Gymnosperms in China*, *Wood Properties of Planted Trees in China*, etc.

Wood functional improvement

The drying schedules of 63 major wood species in China were presented for the first time and an industrial standard – the Processing Procedure of Kiln Drying for Sawn Timber was formulated. CAF invented the Serial LK Wood Drying Equipment automatically controlled by microcomputer. WP wood preservatives and WFR wood retardants produced by CAF have been applied in maintaining ancient architecture such as Tian'anmen Gate Tower in Beijing and Potala Palace in Tibet. Research findings on modifying poplar wood properties, including technology of retardant and reinforced wood and compressed veneers, have helped increase the products' added value.

Wood-based composites

CAF initiated the development of wet-process fiberboards and particleboards in 1950s' and then dry-process fiberboards and MDFs in 1970s'. Since early 1980s' it has started the application of non-

timber materials in producing new wood-based composites. The Research on Wood Properties of Planted Trees in China analyzed and determined the property indicators of 18 provenances and 15 families of *Pinus elliottii* and disclosed the variation rules of its wood properties from different provenances, families and parts. The relation between wood properties and veneer and plywood quality of poplar wood from planted forests was studied. Technology in producing wood-based panels was improved and produced products included aircraft plywood, dry-process fiberboards, MDFs, embossed fiberboards, cement particleboards, finger-joint plywood, artificial decorative films, etc. Technology in producing straw-based panels was studied and developed, producing products of straw-based particleboards, straw-based MDFs, packaging materials made of cornstalks, fiberboards made of cotton stalks, wood-bamboo-straw composite panels, etc. Composites made from plant fibers and plastics have been developed, including wood-plastic profiles, wood-plastic fiberboards, wood-plastic particleboards, wood-plastic plywood, etc., which are applied in interior car decoration, gardening structures, furniture, etc. Environmental detecting technology was developed for man-made panels and their products and the detection is applied in the whole process of their production.

Materials for wood structures

Materials for wood structures were studied, developed and applied. New materials of three classes and eight categories were invented, such as dimensional fir lumbers from planted forests. CAF has established the largest lab in China working on wood structures. Key



RESEARCH FIELDS OF EXCELLENCE

technologies for applying timber planted in China in light wood structures, such as grading of sawn timber, veneer splicing and softening, framework and surface material production, etc.



An octagonal pavilion made by Larch structural wood

Bamboo-based engineering materials

Significant breakthroughs have been made in the technology of bamboo-based engineering materials manufacturing. Innovations of structural design,

processing techniques and product development have been accomplished in applying bamboo-based structural materials, decorative materials and bamboo charcoals. 32 kinds of grand new bamboo-based products were developed. The technological research on producing high-performance bamboo-based fiber composites has broken through the crucial technology in producing bamboo veneers and invented four lines of high-performance bamboo-based fiber composites.



The application of bamboo-based fiber composites on the blade of 1.5-MW wind turbine



The application of bamboo-based fiber composites in Shiliutan Park



RESEARCH FIELDS OF EXCELLENCE

FOREST PRODUCT CHEMISTRY

Chemical utilization of wood

Research on chemical utilization of wood has been carried out and techniques in intensified hydrolysis, heat recovery, gas and power generation from wastes, and gas-phase and atmospheric-pressure production of furfuryl alcohol.



3MW biomass conical fluidized bed gasification power generation system equipment

R&D on citric acid-specific active carbon was conducted and achieved that more than 50% of the production were 2-10 mm aperture-volume active carbon. Directional preparation technology of micro-structures and surficial groups of active carbon was developed and breakthroughs were made in directional regulation of ultramicropore structures, selective decoration of surficial groups, low-molecular and self-forming pelleting of wood materials, etc. Bamboo was directly applied in preparing bamboo charcoal, active carbon and bamboo vinegar powder and the continuous automation equipment developed by CAF has diversified the uses of bamboo. Thermal pyrolysis technology of residues from agricultural and forestry production to co-produce carbon materials has been advanced and new thermal pyrolysis equipment has been invented.



Activated carbon products

Crucial technology of directional production of liquid fuel co-products has been developed. Both technology and equipment of energy-saving mechanical pulping using low quality fiber were innovated and water-conserving bleaching technique which can recycle the bleaching liquor was developed. High-efficient pulp making from low-quality wood was studied.



Hydrocarbon-rich fuel production line



The high yield and clean poplar residues pulping production line with domestic equipments



RESEARCH FIELDS OF EXCELLENCE

Chemical utilization of non-timber materials

In regard of the chemical use of non-timber materials (including leaves, barks, resin, fruits, understory plants, etc.), chemical resin tapping method and continuous distillation process were proposed, with reprocessed products of polymerized rosin, hydrogenated rosin and abietin produced. Diverse products made of tanning extracts were manufactured using continuous level rotary extractors and double-effect falling film evaporation. Preparation and production techniques of tannic acid and gallic acid were studied, and serial highly processed products of pyrogallol, trimethoxybenzaldehyde and trimethoxybenzoic acid were developed. More than 10 new natural compounds were isolated and identified, and active substance analysis methods and extraction techniques of pine needles, ginkgo leaves, seabuckthorns, poplar tree barks and five-leaf gynostemma herb were developed. Equipment of high-pressure hydrogenation of rosin, continuous level rotary extractors of tanning extracts, high-speed centrifuging and spraying drier, etc. were invented. Techniques were developed in desensitization of lacquer trees, extraction of active substances, purification of raw lacquer, preparation of urushiol acetal derivatives, etc. New lacquer-based tannic composite paints and fine urushi wax were produced.

Utilization of resource insects

Breakthrough has been made in the overwintering breed conservation of *Laccifer lacca* and broodlac bases were planned with improved breed conservation rate based on the understood interrelationship between insect mortality and various ecological factors. Nearly 200 host tree species for *Laccifer lacca* were discovered and 13 quality hosts were selected. The first

Laccifer lacca germplasm bank and associated quality insect selection and propagation platform in the world was established, where 10 strains of 9 *Laccifer lacca* species and 256 host plants were collected and conserved. Hypothetical mechanism of wax secretion of white wax insects was proposed and applied in the in-situ insect and wax production model. Integrated development technology for *Phyllanthus emblica* Linn. and *Rhus chinensis* Mill. was developed.



Lac-plantation-farmland ecosystem



Lac



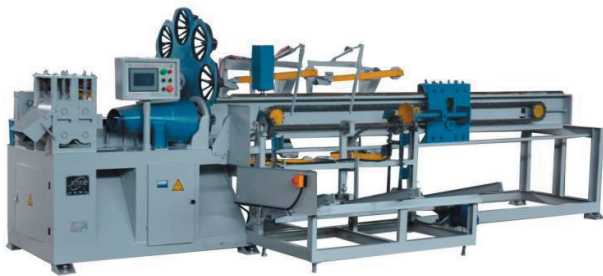
RESEARCH FIELDS OF EXCELLENCE

FORESTRY MACHINERY

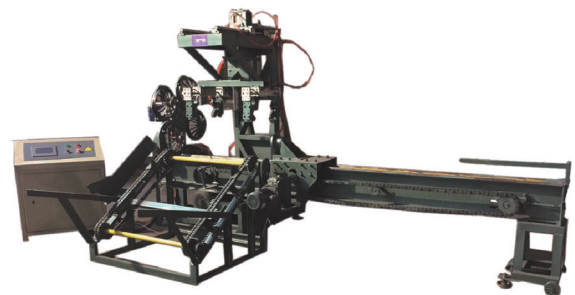
Since its establishment till 1965, CAF had generated more than 20 research outcomes including seedbed soil covering machine, watering vehicle and mobile chipper. Six achievements, including three types of sprayers of artificial rain device, self-priming pumps, nursery bed builder, lightweight excavator, big seedling planter and integrated utilization of logging residues, won the scientific awards of Heilongjiang province in January 1978. Forestry sprinkling irrigator, KDZ big seedling planter, integrated user of logging residues, nursery bed builder, Z4JM-2.5 wood loader invented by CAF won the national scientific awards in March 1978. More than 20 scientific achievements, such as the ZLM-50 loader, were obtained in 1980s'.

The automatic seedling replanting technology and equipment was developed. The production line of cement particleboards with an annual output of 30,000 m³, automatic computing and controlling system for wood drying, wood moisture content tester, boiler electronic water treatment instrument, steel pine polisher, and production line of calcium-silicon bricks were invented. A series of machines for deep and fine wood processing, including numerical

control machining center, computed glue supplier, glue sprayer and mixer, numerical control router, bifacial vacuum laminator, etc. were invented and placed in market. High-speed motorized spindle for wood processing was studied, and the integrated structure of motorized spindle system of NC machine and high-speed electrical machinery were created to replace the conventional transmission gears, which can not only increase the production efficiency, but also improve the surface quality and fineness of the processed products. Technologies and equipment for producing recombined bamboo materials in its original state, bamboo-based oriented strand boards (OSB) and large dimension bamboo split OSB were developed. Load-bearing processing machinery for manufacturing bamboo-based composites was developed at a certain scale, which can significantly help upgrade the processing technology to support bamboo industry. The concept of recombinant bamboo in its original state was proposed for the first time and key equipment for producing associated products was developed.



CNC automatic bamboo breaking machine



Automatic grading bamboo breaking robot



RESEARCH FIELDS OF EXCELLENCE

FORESTRY DEVELOPMENT STRATEGY

CAF has been involved in the study of forestry development strategy since 1957. With its research on the forestry development strategies, forest economics and decision-making approaches at different historic periods, CAF has provided an operational forestry development model appropriate for China's state circumstances and forest status. Concept frameworks of forest management themed as Coordinated Economic and Ecological Development, Specialized Forestry Practitioners, etc., were proposed. Commercial values of forests were studied and justifications and implementation approach of forest valuation were provided. The philosophy of forestry specialization was suggested and demonstrated by the research team of China forestry development path. Research findings were also generated in term of China's forest industrial policies and regional comparative study in this regard.

Numerous outcomes were produced in forest science and technology development strategies, planning, evaluation and S&T institutional reform, with the medium and long-term program for forest S&T development developed. The 21st Century Agenda Forestry Action Plan of China was formulated, presenting a blueprint of China's forestry development oriented towards the 21st Century and providing the strategical goals of China's sustainable forestry development and associated countermeasures. The quantitative analysis and measurement of S&T achievements' contribution to forestry economic growth was studied and concepts of contribution rate of forestry S&T progresses and application and transformation rate of their outcomes were proposed. The project of Study on Forestry Strategy for China's Sustainable Development, initiated by the State Forestry Administration and implemented by CAF, established the strategic guidelines for

China's forestry development strategy. It was the so-called "3-Ecos" strategy, namely covering the establishment of sustainable forestry development path based on ecological construction, establishment of national ecological security system based in forest vegetation, and establishment of an ecologically civilized society with beautiful and vegetated mountains". The research findings were fully acknowledged and included in the State Council Resolution on Accelerating Forestry Development, which provided sufficient scientific evidence for the long-term policy and decision-making. In addition, the social forestry system was studied and C&Is for evaluation social forestry programs at both national level and provincial level were established. A total of 325 models of social forestry programs and 175 integrated technical models at provincial level were provided. The forest tenure reform monitoring and evaluation system was studied and an integrated technical system for monitoring the resources, ecological and socio-economic benefits generated in the reform areas was provided, which also developed the resource information system integrating GIS, RS, PDA and database.

For the six decades since its establishment, CAF has made remarkable scientific achievements. For instance, CAF has published 7,351 papers since 1989, including 2,628 papers (1981-2017) included in SCI index journals and 1,179 papers (1992-2017) including in EI journals.



Kick-off Meeting of Greater Dunhuang Ecological Protection and Regional Development Strategy Project