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Dear Readers

Welcome to the 38th issue of APANews! This issue features interesting articles on potential species that could be integrated in agroforestry systems and findings of documentation on agroforestry models in Viet Nam and India.

One article presents the profiles of different agroforestry models that exist in northern and central Viet Nam, including the mangrove areas. The article discusses agroforestry models based on landscape, and available knowledge and policies in implementing agroforestry. Find out how the findings of this study were used to identify the challenges and gaps that would further improve Viet Nam's agroforestry research and development in the next five years. Areas of focus are agroforestry approaches, land-use planning based on landscape and sociocultural economy, agroforestry techniques, functions of agroforestry in environmental services, and policy development.

Two articles from India present species that could pose additional income to farmers if successfully integrated in agroforestry systems.

One article features *Salvadora oleoides*, a small multipurpose tree that produces desert grapes. Aside from its fruits, the tree is also tapped for oil, fodder and wood. Read more about the important uses of this species including its origin, distribution and how it can be propagated and protected. The article also discusses how the species can be conserved *ex situ* and through gene banks and cryogenebanks.

The other article, meanwhile, discusses *Pongamia pinnata* as an alternative source of biofuel. Find out how *Pongamia pinnata* can be tapped as a biofuel and consequently help augment the global supply of petrofuel.

Another article from Viet Nam discusses Agarwood (*Aquilaria crassna)*, a popular source of wood chips, incense and essential oils. The article discusses agarwood's morphology, ecology and distribution, propagation, transplanting techniques and inoculation. Read more about the benefits of agarwood and how it can be integrated successfully in agroforestry farms.

You might also find interesting an article that discusses how agroforestry can help address the plight of farmers in India. The author provides a refresher on the benefits of agroforestry and its capabilities to provide basic needs, restore land productivity, reduce soil erosion and improve soil fertility. Read more on how the adoption of agroforestry can help improve the quality of life of farmers in India as they have improved the lives of others who have practiced its different systems.

As always, we feature interesting events, websites and information resources that you might find useful as you adopt and practice agroforestry and its various support technologies.

Thank you once again to all the contributors. Let us continue sharing knowledge in agroforestry research, promotion and development, and education. As we share knowledge, we also learn from it, and more importantly use it to improve lives. —*The Editors*

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COVER. *Pongamia pinnata* is a nitrogen-fixing tree tree that produces seeds containing 45 percent oil. The oil is tapped as a substitute for biodiesel (*see story on page 14*).

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Promoting the use of *Salvadora oleoides* as a multipurpose agroforestry species

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Deserts occupy an estimated one-seventh of India's land surface. Moisture is either absent or very low. Deserts depend solely on the balance between precipitation and evaporation.

Deserts have played a key role in human evolution and adaptation. The Thar Desert, one of the largest deserts in India, occupies about 60 percent of Rajasthan state. Most areas in the Thar Desert consist of dry undulating plains of hardened sand, while the rest of the area largely comprises rolling plains of loose sand that form shifting sand dunes which are 2–10 km long and 20–30 m high.

The Thar Desert is one of the most heavily populated (in terms of both people and cattle) deserts in the world. The animal and human populations exert tremendous pressure on the scant vegetation in the region. Plants are thus vulnerable to becoming endangered. Inherent biological problems associated with these plants make their survival difficult, resulting in forced adaptation to the desert's harsh environment.

The topography of the Thar Desert is distinctly marked with sand, scattered rocky ridges and steep slopes. Topography and climatic factors play a significant role in determining vegetation types. Most of the vegetation consists of stunted, thorny or prickly shrubs of *Acacia senegal*, *Capparis decidua*, *Calotropis procera*, *Calligonum polygonoides*, *Prosopis cineraria*, *Salvadora oleoides*, and *S. persica* (Gupta and Prakash 1975).

Salvadora oleoides, popularly known as *pilu*, is a small, multipurpose agroforestry tree commonly grown in western Rajasthan and Gujarat states of India (Kaul 1963). *S. oleoides* is also called *jhal*, *bahapilu* and *khakan*. The tree is primarily sourced for its fruits known as desert grapes. The seeds are also sources of oil used in the manufacture of soaps.

Species profile

Salvadora oleoides is a small evergreen tree with a short, twisted trunk and drooping branches that provide a thick shade (Figure 1). A dense, almost impenetrable growth is often formed by a parent stem surrounded by a ring of root suckers. Seedlings also sprout under its shade. The species, however, is very slow growing. The branches are often lopped for camel and goat fodder.

Under favorable conditions, *S. oleoides* grows up to 6-9 m high with a trunk of up to 2 m in diameter. The bark is light gray to gray. The leaves are fleshy and have a pungent smell. The shape of the lamina is linear lanceolate, and leaf size ranges from 3-10 cm x 0.3-1.2 cm. New leaves usually appear in April.

The tree generally flowers in March-April. The flowers are sessile, greenish white in color and clustered. Inflorescence is paniculate spike.

The fruits are drupe, clustered, and grow up to 0.40-0.45 cm in diameter. They are yellow or greenish yellow when ripe, and are sweet with a bit of pungent taste. In some cases, the fruits are pink and violet (Figure 2). The fruits can be harvested in June.

Distribution

S. oleoides is commonly found in tropical Africa and Asia, extending to Egypt, the Mascarene Islands and China. The indigenous tree grows on dry, saline and desert areas of Rajasthan, Haryana, Punjab, Gujarat, and Madhya Pradesh. *S. oleoides*, as well as *S. persica*, grows well in the sand dunes of deserts to heavy soils, non-saline to highly saline soils and dry regions

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Fig. 1 Salvadora oleoides tree with its drooping branches.

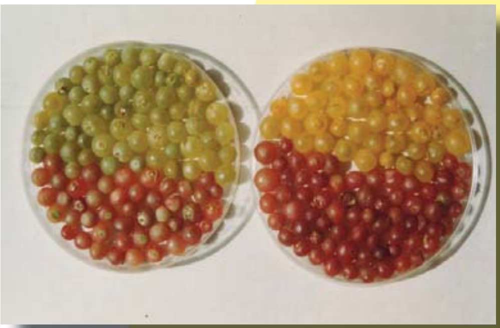

Fig. 2 The fruits of S. oleoides vary from yellow, greenish yellow, pink and violet.

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to marshy and waterlogged areas (Figure 3).

The species adapts well to arid conditions and is salt-tolerant and drought-resistant. It is distributed to some extent in Andhra Pradesh, Karnataka and Tamil Nadu. It is also found in the Sunderban mangroves of West Bengal and in the regions of Chilka lagoons. The tree species is known to tolerate a very dry environment with mean rainfall of less than 200 mm in Barmer, Jalore, Jodhpur, and Pali districts of Rajasthan (Figure 4) (Bhandari 1990).

Fig.3 Salvadora oleoides trees are grown on sandy saline soils in the arid zone of Rajasthan, India.

Fig. 4. Distribution of S. oleoides (SO) and S. persica (SP) in the arid areas of Rajasthan, India.

S. oleoides and *Capparis decidua* form the major arboreal part of the flora in these areas. The tree species is also suitable for shelterbelts and windbreaks in arid zones, and used to reduce soil erosion. It survives at an altitude of 1 000 m (Khan 1955; Kaul 1963; Khan 1994). The plant tolerates temperatures between 3 to 48°C. *S. oleoides* can be found growing in groups of up to 50-500 trees in its natural population, and can age up to 150 years old. Natural populations of *S. oleoides* can be found in northwest India.

Uses

S. oleoides is known for its fruits or the popular desert grapes. The pulp of desert grapes contains glucose, fructose and sucrose with Total Soluble Solid (TSS) as high as 20-25°B. It is rich in calcium.

The tree is often lopped for fodder to increase milk production in camels. The seed cake is also used as livestock fodder and contains 12 percent protein. Sheep and goats often graze the tree. Aside from fodder, the tree is also sourced for fuel, timber and medicinal values.

Seeds are greenish-yellow and measure 3 mm in diameter. They contain 40-50 percent of a yellow greenish oil with 47 percent lauric and myristic acids. The oil is used to make soaps, candles, and other commercial or industrial products. The acids are used to produce lauryl alcohol (Chatterjee and Pakrashi 1995).

The wood of *S. oleoides* is light red or yellow and weighs about 608-865 kg/m³. The wood is moderately hard, with small, irregular and purple heartwood. It is used for construction and building Persian wheels and boats, and as agricultural implements. The wood is used as fuel when mixed with deodorant and pine scrap wood.

S. oleoides seed oil showed 100 percent toxicity to *Anopheles stephensi* at 0.01 percent. The root bark is used as a vesicant for toothache. The fruits are used as a cure for enlarged spleens, fever and rheumatism. The seeds are also used to cure rheumatic pain, as suppositories and an ointment base. The leaves, meanwhile, are used to relieve coughs, and given to horses as a purgative. The leaves are also good sand binders.

Propagation

S. oleoides can be regenerated by seeds, coppices and root suckers. However, very little information is available regarding seed germination. Natural regeneration of plants from seeds is rare, probably because seeds mature at the onset of the monsoon season. Seeds are therefore susceptible to fungal attack (Mertia and Kunhamu 2003).

The seeds of *S. oleoides* are not stored because viability is not retained. It is therefore recommended that fruits are immediately depulped (Hockings 1993). Depulping the fruits and pre-treating the seeds promote early germination. Freshly harvested seeds with 26 percent moisture content showed 90 percent germination. Viability of seeds is reduced by 50 percent 15 days after harvest, and 100 percent after 24 days of storage. Excised embryonic axes from the stored seeds showed better viability as compared to whole seeds. This indicates the presence of some inhibitory substances in the cotyledons which cause the lower viability of seeds.

Conservation

Research. The gradual decline of *S. oleoides* trees from their natural population requires immediate attention. Conservation of superior germplasm of *S. oleoides* is critical, including research on the tree's basic ecological adaptations, vulnerability to pests and diseases and status of distribution. This information will help manage suitable genotypes and improve the genes used in plantation forests and agroforestry systems.

The National Bureau of Plant Genetic Resources in New Delhi collected germplasm of *S. oleoides* from 25-30 natural populations in the 12 districts of Gujarat, Rajasthan and Haryana states. The collected germplasm was used to vary the genes, and study growth pattern and physical parameters. A total of 23 accessions of *S. oleoides* and 12 accessions of *S. persica* were cryostored at the bureau. Efforts were also made by the Central Arid Zone Research Institute in Jodhpur to select, conserve and protect *S. oleoides* from pests and diseases.

Despite the importance of *S. oleoides* trees, a lot of work is still needed to promote its sustainable use. Due to lack of conservation initiatives, good quality trees from natural populations are gradually declining. Forced acclimatization to extreme climatic conditions will lead to an irreversible loss of plant genetic resources resulting also in environmental and socioeconomic losses.

Most of the studies on Salvadora species focus on the chemical composition of seed oil and juice and its nutritional and medicinal attributes. To maintain genetic fidelity through generations, the selected genotypes have to be clonally propagated. Tissue culture is used to propagate *S. oleoides* from 20- to 30-year-old mature trees.

In vitro multiplication. The in vitro multiplication of Salvadora, using various explants, like axillary buds and shoot tips, has been tried. An average of 5-10 shoots per explant was developed and transplanted after rooting and hardening (Raj Bhansali 1999; Batra *et al*. 2001; Mathur *et al*. 2002a&b). To achieve this, trees are pruned/lopped during December-January or June-July. Fresh sprouts are used as a source of explants. The nodal shoot explants of mature trees are used for regeneration through axillary bud proliferation. Among the various growth regulators, the combinations of NAA and BAP were found to be the best for bud breaking. The maximum number of shoots (5 shoots per explant) can be differentiated on MS + 0.1 mg/l NAA + 2.5 mg/l BAP or 2 iP or kinetin + additives, within 15-25 days (Figure 5).

In vitro raised shoots root using pulse treatment of 100 mg/1 of IBA in half strength and MS liquid medium for 24 hours in the dark. The IBA pulsed shoots root on incubation at an elevated temperature of $33 \pm 2°C$ for seven days in the dark on semi-solid, hormone-free half strength MS agar medium containing 0.5 percent activated charcoal. Initial incubation in the dark at $33 \pm 2°C$ favored rooting.

Shooting/rooting rates of up to 4-5-fold and 60-70 percent rooting percentage can be achieved. Plants were hardened in the greenhouse and then transplanted to pots and subsequently in the field at various sites in Rajasthan. It was noted that low micropropagation and lower rooting rates were experienced in clonal propagation (Singh and Goyal 2007).

***In situ* and *ex situ* methods.** Conservation of *S. oleoides* can also be done through *in situ* and *ex situ* conservation methods. *In situ* conservation uses a gene bank. A gene bank is a live collection of plant species and ecotypes. *Ex situ* conservation of *S. oleoides*, meanwhile, is important to safeguard genetic wealth and promote the use germplasm to develop desirable cultivars or varieties. Field gene banks are often used to conserve *S. oleoides*.

Direct seeding. *S. oleoides* is also capable of regeneration through direct seeding and transplanting of nursery-raised seedlings in the field. There is therefore a need to enhance the incorporation of *S. oleoides* in afforestation and vegetative restoration of the Thar Desert.

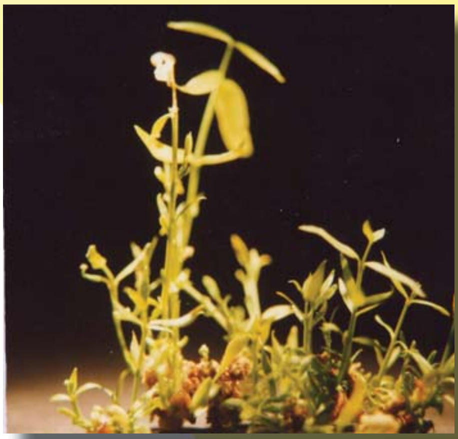

Fig. 5 Tissue culture is used to regenerate S. oleoides.

Fig. 6 The conservation of plant germplasm, through seed collection, is the most convenient and reliable method being practiced in gene banks.

Cryo gene bank. Conservation of *S. oleoides* is also undertaken through the cryo gene bank at the National Bureau of Plant Genetic Resources. The conservation of plant germplasm, through seed collection, is the most convenient and reliable method being practiced in gene banks (Figure 6). Since *S. oleoides* seeds lose viability during storage, further research is necessary to study basic seed physiology, longevity and seed storage behavior. Ongoing research focuses on the conservation and protection of the species from pests, protection of native flora, and other areas with economic implications.

Protection

According to local people, *S. oleoides* trees have undergone profuse flowering but negligible fruit setting in the last 10-12

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years. The reasons cited by the local people were changing environmental conditions which caused severe incidences of pests and diseases. During the rainy season in the arid zones, *S. oleoides* trees were severely attacked by insect-borne phytoplasma disease, which caused the Witches' broom disease in the tree's inflorescence (Raj Bhansali 2010). The affected trees produced very poor fruits as the flower buds were transformed into vegetative parts (Figure 7). The leaf hopper was also found to be a cause of the Witches' broom disease.

Further, *S. oleoides* that grow on river terraces are usually attacked by *Cistanche tubulosa*, an obligate phanerogamic root parasite (Figure 8). The young trees are also attacked by *C. tubulosa*, a plant parasite, on subsurface roots during high moisture conditions. This parasite is unable to directly synthesize chlorophyll and therefore has no green coloration. It is a widely distributed annual that produces a dense pyramid spike of bright yellow flowers topped by maroon-tinted buds (Figure 9). The parasite produces many tiny seeds which may remain dormant for years until the roots of its host plant are close enough to trigger germination.

Rarely fruiting bodies of basidiomycetes cause trunk rot in age-old trees. This is evident in trees grown in saline-affected rangelands. A number of fungi, such as *Cercospora udaipurensis*, *Placosoma salvadorae* and *Sephogloeum salvadorae*, also damage the leaves.

The defoliating larvae of several beetles attack the tree, and leaves are often attacked by the lepidopteran pest (*Colotis ephiae*). The mite Eriophyes causes leaf gall, leaf hopper and *Microtermes mycophagus* infest old natural plantations of *S. oleoides* (Figure 10).

Conclusion

Minimal efforts are being done on the characterization, evaluation and conservation of Salvadora germplasm. Moreover, there is a need for further research on the possibilities of the fruits of Salvadora to be transformed into other products.

Domestication helps to ensure that a species is conserved and used commercially in a sustainable manner. Biodiversity conservation of Salvadora species should employ *in situ* and ex *situ* conservation methods both in the natural habitat and gene banks, respectively. *In situ* conservation promotes the growth of plant species in their natural habitats where evolutionary processes continue to operate, making it a dynamic system. The majority of the underutilized fruits grow in diverse climatic and edaphic conditions and are adapted to arid and semi-arid conditions. *In situ* conservation is important for *S. oleoides* which are still growing in the natural habitats or in semi-domesticated conditions.•

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Fig. 7 The Witches' broom disease transforms flower buds of S. oleoides into vegetative parts.

Fig. 8 and 9 Evidences of attack of phanerogamic root parasite (Cistanche tubulosa) on S. oleoides.

Fig. 10 Insects cause the Witches' broom disease in S. oleoides.

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State of agroforestry research and development in Viet Nam

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Evaluating agroforestry research and development in Viet Nam is a difficult undertaking. The results of agroforestry studies in the 20th century are mainly grey literature comprising scientific reports, theses and conference reports. Very few studies have been published.

Further, there is a lack of documentation on the diversity and improvements made to the practice of agroforestry in the country, limited research and systematic reviews on the effectiveness of different agroforestry models, and very little information on the sustainable use of water and land resources in the different agroforestry systems. This study tried to summarize existing research on agroforestry and consolidate the practical experiences of farmers as a basis for further research and development initiatives.

Agroforestry models

Khoa *et al*. (2006) reviewed and classified different agroforestry models in Viet Nam according to location.

In the mountains of northern Viet Nam, farmers were found to practice: (i) forest + farm or pasture + rice terraces + vegetable garden; and (ii) forest + farm + garden + rice terraces. These areas are prone to erosion, resulting in thin soil layers. The soil is acidic with moderate to high humus content. Farmers practice rotational cropping of cereals and legumes.

In the hilly areas of Viet Nam's northern midland and central provinces, farmers established 1-2 ha of forests in the steep slopes. Farms of upland rice are found along the hillside areas which comprise 0.5-1 ha. Meanwhile, 0.2-0.3 ha of gardens have been established at the foothills, near valleys and roads.

The soil in the mid-central areas often experience erosion resulting in thin topsoils and low soil fertility. Only sparse vegetation can be found in these areas. Because of the situation, farmers established garden-based agroforestry with livestock-raising and fish production.

Areas in the central highlands are 400-900 m asl. The soil is fertile. These areas also experience shortages of water supply.

Most forests in these areas were initially cleared to establish industrial tree plantations. Nowadays, farmers intercrop industrial trees with agricultural crops.

The Cuu long delta, meanwhile, has high soil fertility because of the Mekong River, and is therefore suitable for establishing fruit orchards. Farmers in these areas intercrop fruit trees with agricultural crops.

Agroforestry is also practiced in the coastal mangroves of Viet Nam. These areas are submerged lands and wetlands with tidal salt water. The area also experiences flooding of fresh water during the rainy season.

Farmers in these areas primarily practice: (i) mangrove + shrimp, crab or fish culture; (ii) agriculture (wetland rice) + forestry (Indigo forest) + fishery + apiary + VAC (V: Garden, A: Fishpond, C: Pigpen); and (iii) vegetable garden + fish pond + fish breeding in the residential land. Farmers have adopted these systems according

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to the aquatic species to be used, water temperature, water type (salt and fresh water), water turbidity, and alum chemical processes.

Improvements in agroforestry research

Over the years, diagnostic tools have been developed to classify agroforestry models using participatory technology development (Bao Huy *et al*. 2003). Analyses on the impact of environmental policies on the development of agroforestry in the country; the practice of agroforestry on land use, landscape and socioeconomic environment; and adoption of agroforestry are also being done. Recent research are now combining new methods, particularly in the areas of soil science, plant physiology, ecology, systems science and modeling, quantitative analysis, etc.

Agroforestry models based on landscape

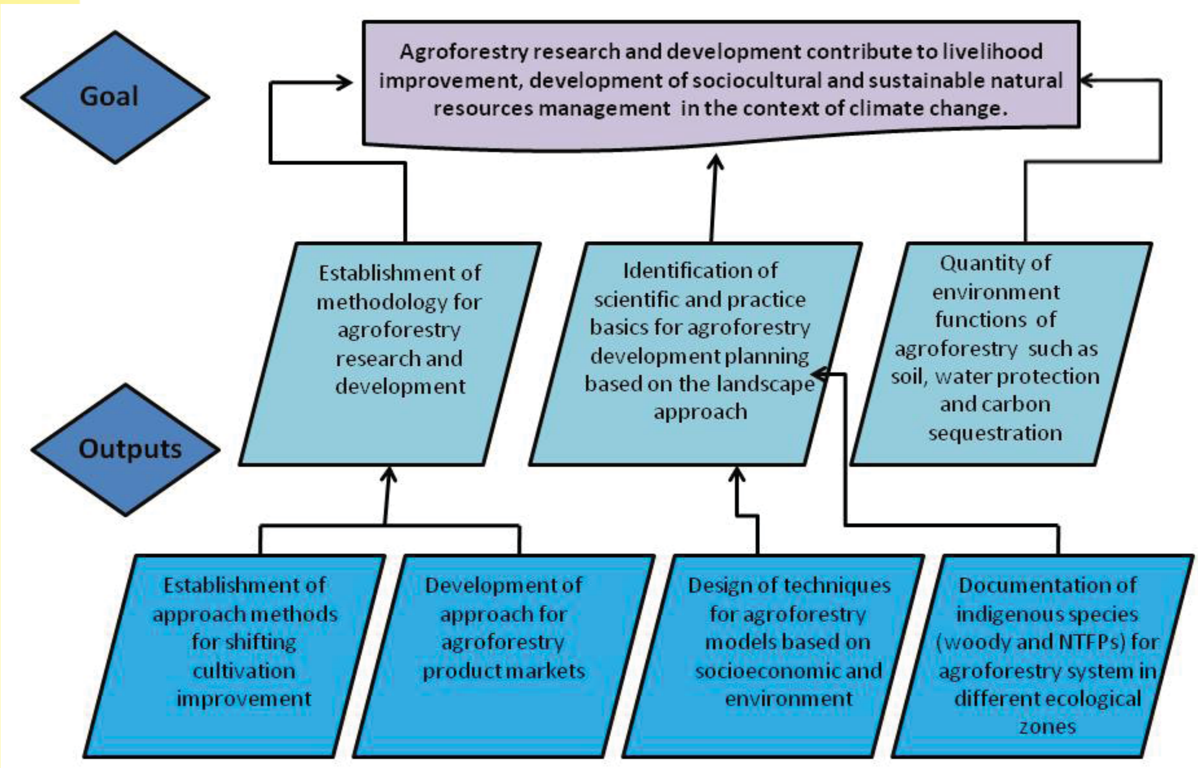
Research on the concepts and approaches of agroforestry models based on landscape is relatively new in Viet Nam. In the last five years, research on agroforestry landscapes were considered in evaluating the relationships between natural and socioeconomic factors which are the basis of arrangements of the agroforestry landscapes.

In 2008, with the support of the Viet Nam Network on Agroforestry Education, investigation, research and documentation on three model agroforestry landscapes in three ecological zones were conducted. They were: (i) agroforestry landscape of forest-tea-rice-crops-livestock in Xuan Phuc, Thai Nguyen City, Thai Nguyen province; (ii) agroforestry landscape of coffee crops-cashew-fruit trees-crops-livestock in Cu Pui, Krong Bong district, Dak Lak province; and (iii) agroforestry landscape of forest gardens-perennial crops-fruit trees Tanh Linh, Tanh Linh district, Binh Thuan province.

Agroforestry research

Focus. In the next two to three years, research in agroforestry will focus more on the impacts of climate change and the role of agroforestry systems in carbon dioxide absorption. At present, studies have been conducted on the capabilities of agroforestry for carbon sequestration, such as the rapid assessment of the ability to accumulate carbon in agroforestry, in the buffer zones of Tam Dao National Park, Vinh Phuc province. A recent study by Bao Huy *et al.* (2009) estimated the absorption of CO_2 in by litsea (*Litsea glutinosa*) in an agroforestry model of litsea + cassava in Mang Yang district, Gia Lai province. Results showed that the total economic value of cassava and litsea in five years is 2 024 USD (42.5 million VND) per hectare, and CO_2 absorption is 24.7 tons per hectare valued at USD424 (VND8.9 million). Further research along this area is needed to provide critical information on the contribution of agroforestry in mitigating climate change.

In the next five years, further research on agroforestry development is needed, particularly in the areas of approaches and methods, agroforestry planning based on ecological landscape and policy development, sustainable management of upland resources, technical issues, indigenous crops, role of agroforestry in payment for environmental services, improvements in production,



economic efficiency and development of markets for the products of different agroforestry models (Figure).

Gaps. The table summarizes the research gaps and needs based on literature reviews.

Conclusions and recommendations

The study documented some different agroforestry models existing in Viet Nam. Techniques in trees species selection, arrangement of different agroforestry components and nursery establishment were found being taught in secondary schools and universities. The focus of research has also changed to highlight practice rather than concept. In addition, recent research findings have affirmed agroforestry's role in economic development, soil and water conservation and protection, biodiversity conservation and carbon dioxide absorption.

However, the study also listed several gaps and limitations in agroforestry research and development under the areas of approaches, land-use planning based on landscape and sociocultural economy, agroforestry techniques, functions of agroforestry in environmental services, and policy development. These include the missing link of recent research and development initiatives to sustainable land-use planning, insufficient information on marketing models, lack of documentation on indigenous knowledge, and lack of further research on the systematic domestication of forest trees, production of non-timber forest products, and crop diversification. Other areas that need to be studied are the contribution of agroforestry systems to climate change, conversion of areas under shifting cultivation to agroforestry, and contribution to livelihood improvement, sociocultural development and sustainable

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Table. Research gaps and needs in agroforestry research and development in Viet Nam.

Expected research results	Available knowledge and policies	Research gaps and needs
Complete methodology and approach in agroforestry research and development	Participatory technical development	Methodologies on the technical, economic, social, humanitarian and environmental approaches
Established approach and methodologies to improve the practice of shifting cultivation	Documentation of indigenous knowledge on shifting cultivation	Methodologies to improve shifting cultivation based on local ecological knowledge
		Development of policies on fallow land management
Developed markets for agroforestry products	Evaluation of market chains in remote areas	Evaluation methods to assess agroforestry markets
		Methods to develop sustainable markets for agroforestry products
Established scientific basis in support of agroforestry planning based on landscape	Development of agroforestry landscapes	Establishing scientific basis for land-use planning based on the landscape approach
	Participatory land-use planning	Complete participatory methodology on forest land allocation
		Development of policies/laws on sloping land management towards agroforestry
Complete agroforestry systems based on socioeconomic and environmental factors	Techniques for designing space and timing of crops and forest trees in some ecological zones	Methods and structure for the design of agroforestry systems based on economic and environmental factors
Integration of indigenous forest trees and non-timber forest species in agroforestry systems according to different ecological and human culture zones	List of forest trees and non-timber species in some ecological zones	Updated list of forest trees and non-timber forest species that could be integrated in agroforestry systems
	Cultivation techniques of some forest trees and non-timber species in some ecological zones	Cultivation techniques of timber and non-timber that have potential to be integrated in agroforestry systems
Environment functions of agroforestry systems, such as soil and water conservation and protection, and CO_2 sequestration	Initial research on CO_2 sequestration of agroforestry systems	Extent of water conservation and protection of agroforestry systems
		Extent of soil conservation and protection of agroforestry systems
		Extent of estimated CO_2 sequestration of agroforestry systems
		Policy development payment for environment services of agroforestry systems

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natural resource management in the context of climate change.

The study therefore recommends long-term research on this topic, incorporating the knowledge and experiences of experts and practitioners, and identification of further research topics in coordination with the state, ministry, and provincial levels of government.•

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Promoting agarwood-based agroforestry systems in north central provinces of Viet Nam

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Agarwood (*Aquilaria crassna*) is considered one of the ecologically and economically valued timber trees in Viet Nam. It is popularly known as *cay tram huong* or *do bau* in Vietnamese. Agarwood is naturally distributed in the central highlands, north central and the southeastern areas. It is widely grown in the north central area, particularly from Ha Tinh to Thua Thien Hue provinces. It is known to provide many valuable products such as wood chips, incense and essential oil. Agarwood oil is used as raw material for perfume and as traditional medicines. Agarwood is sold for USD 20 000-30 000 per kilogram.

Morphology

Agarwood is a medium-sized tree of 15-20 m high or more. The trunk diameter is 40-60 cm to 1 m dbh. The bark is tough and fibrous, while the leaves are simple, alternate, oblong and 3-5 cm wide and 6-15 cm long. The leaves are green at the top and pale yellow underneath.

The flowers are racemose, umbelliform, and bisexual. The calyx are tubular. Petals are absent in the flowers. There are two stamens in two whorls. The ovary is scale-like, annular or cup-shaped. The fruits are loculicidal capsule, mostly indehiscent. The seeds exist with or without the endosperm.

Agarwood has dark resinous heartwood that forms in Aquilaria trees, which are large evergreen trees that are native to southeast Asia and Viet Nam. The heartwood of agarwood is relatively light and pale. However, once it becomes infected with mold, the tree produces a dark aromatic resin which results in a very dense and dark heartwood. The resin-embedded wood is commonly called gaharu, aloeswood, agarwood or oud and is valued in many cultures for its distinctive fragrance. The resin-embedded wood is also used as raw material for incense and perfumes. It is for this reason that aquilaria trees have been listed as a potentially threatened tree species since 1990.

Plant ecology and distribution

Agarwood is naturally distributed in semi-deciduous to evergreen forests at altitudes of 50-1 200 m asl on a large range of light- to medium-textured soils of feralite, schist, granite and basalt. It also survives in well-drained soils with thick A-B layers, 0.6-1 m deep or more, 5-20 degrees of slope, with a yearly average temperature of 20-28^{0}C and annual rainfall of 1 500-2 500 mm.

Agarwood has been widely grown in the forests and agroforestry farms of the north central provinces of Quang Binh, Quang Tri and Thua Thien Hue since the 1990s. It is primarily grown to reduce soil erosion.

Propagation

Seedlings are prepared in nurseries for 3-5 months. The sizes of plastic bags are 10-12 cm wide and 15-18 cm high. The medium comprises 87-90 percent soil, 8-10 percent organic manure, and 1-2 percent nitrogen-phosphorous-potassium fertilizers.

The propagation of agarwood is done by collecting seeds from dried fruits. About 10-15 kg of fruits could yield 1 kg (4 854) of seeds. The initial moisture content of seeds is 51 percent and the germination rate is 80 percent.

Upon reaching 25-30 percent moisture content, the seeds are then stored in moist sand and kept in a cool place for two months. The seeds are then soaked overnight in water prior to sowing. Germination is within 8-25 days.

Transplanting

The soil should be prepared prior to the onset of the rainy season, which is in August-September. The hole should measure 40 cm x 40 cm, and 35-cm deep.

Agarwood is planted along the contour lines in forest gardens or along rows in home gardens or boundaries of agricultural farms. Organic fertilizer of 3-5 kg or more per hole is applied, followed by 0.1-0.2 nitrogen-phosphorous-potassium fertilizer per hole 10-15 days before transplanting.

Agarwood can be grown in a spacing of 6 m x 3 m or 510-525 trees per hectare. It can be intercropped with cassava. As windbreaks in agroforestry systems, agarwood is planted at a lower density of 100-200 trees per hectare at 5-m apart. Weeding is done 3-5 times a year, especially while the trees are small. Weeds should be cleared within 1.2-1.5 m diameter around the tree.

Fig. 1 Agarwood (Aquilaria crassna) is known to provide many valuable products such as wood chips, incense and essential oil.

Inoculation

Essential oils are tapped by skilled workers from five- to seven-year-old agarwood. They drill holes in the bark and put powder of agarwood in the holes to attract insects and fungi. Once the heartwood is infected with mold, oils are then secreted and extracted.

Recent research results show that the formation of agarwood occurs in the trunk and roots of Aquilaria trees that were infected by a parasitic ascomycetous mold (*Phaeoacremonium parasitica*), one of the dematiaceous (dark-walled) fungi.

Economic importance

According to international and domestic traders, agarwood provides high quality paper pulp, incense wood, perfume oil and medicinal materials.

Depending upon the extent of resin accumulation, the heartwood is generally classified into Grade A or black and true agar, Grade B or *bantang*, Grade C or *bhuta* or *phuta*, and Grade D or *dhum*.

In black agar, the impregnation of resin is intense, such that the wood resembles black stone. It is heavy and sinks in water. It also bears the highest resin content but is difficult to distill. True agar, meanwhile, is mainly exported to the Middle East to be used as incense. *Bantang* is brown in color without any black tone. *Bhuta* is also brown in color but interspersed with 50 percent or more of yellow-colored wood. These two grades are also usually used in incense. *Dhum* is the lowest grade. The wood is mostly yellow with scattered streaks of brown or black resin. It is chiefly distilled for oil. Sometimes the oil is also extracted from *bhuta*, which is found to be superior to the oil extracted from *dhum*.

The oil is dusted on clothes and skin as protection against fleas and lice. It is also used as fumigators, such as pastilles and agarbatis. The bark is a source of writing material, sachpat, which is immune to insect attack, and used to write religious scriptures

The price of fragrant agarwood is about USD 10-15 per kilogram. The price of perfume oil ranges from USD20 000 to USD30 000 or more per kilogram.

Environmental significance

With a planting density of 400-525 trees per hectare, agarwood is considered as an evergreen canopy which covers 60-70 percent of the soil's surface, especially in areas that have undergone shifting cultivation.

Agroforestry production models

Agarwood is intercropped with cassava, sweet potato and oil palm in agroforestry systems. The intercropping of agarwood and cassava or sweet potato is usually seen in the hilly regions of north central Viet Nam. About 510-525 trees are planted at a spacing of 6 m x 3 m. Cassava is grown between two rows of agarwood, similar to that of the alley cropping system. Meanwhile, about 1 000 trees of agarwood per hectare are planted in the open spaces of 300-500 oil palm trees.

Agarwood can also be intercropped with acacia, upland rice and pineapple. Two rows of agarwood are established per 6-8 rows of acacia. This is equivalent to 200-300 agarwood trees and 1 200-1 400 Acacia trees per hectare. Around 200-300 agarwood trees can be grown along the boundaries of farms planted with upland rice. About 100-200 agarwood trees, meanwhile, can be intercropped with 5 000-10 000 or more of pineapple per hectare. Some farms in Viet Nam also integrate agarwood and fruit trees in their home and forest gardens.

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The recommended planting density of agarwood in agroforestry farms is 100 to more than 500 seedlings per hectare. Agarwood is also best planted in 0.2-0.5 ha of home or forest gardens that are established in hilly areas.

Fig. 2 The intercropping of agarwood and oil palm.

Recommendations

Agarwood is one of the ecologically and economically valued timber trees that could be best grown in home and forest gardens. It can be intercropped with a combination of agricultural crops and fruit trees such as upland rice, cassava, beans, sweet potato, yam, banana, pineapple, jackfruit and many more. Aside from its essential oils, agarwood is also grown to provide shade.

Agarwood in agroforestry systems should be promoted to fully harness the potentials of the tree species. At the same time, oil processing technologies should also be promoted as a livelihood program for farmers and rural communities

Further, international certification of incense and perfume market brands is necessary to standardize the classification of essential oils among users and traders.•

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Restoring land productivity through agroforestry

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In the early days, farmers were the pride of India. They were sidelined as the country became industrialized. Today, the plight of farmers is next to the unemployed youth of the country.

As of 2010, the population of India had reached one billion. More than 70 percent of the country's population resides in villages. Six lakh villages comprise an estimated 105 million farm families. The majority (76.2%) of the communities are marginal and small farmers who only cultivate 29 percent of the total area. About 71 percent of the area is being maintained by farmers who own medium- to large-sized holdings.

Of the country's 328 million ha, only 43.5 percent is under cultivation and supports 70 percent of the country's population. The increasing population is causing the decline in the per capita availability of the land from an estimated 0.48 ha to 0.15 ha by the end of the century.

Assessment of resources

Land. Of India's total geographical area of 329 million ha, about 187 million ha is experiencing water erosion (48.9 million ha), wind erosion (13.5 million ha), and chemical (13.8 million ha) and physical deterioration (11.6 million ha).

In India, the net cultivated area (143 million ha) is one of the highest in the world alongside Russia (10.8 million ha), China (11.5 million ha), Japan (15.5 million ha), the United States of America (16.2 million ha), and Pakistan (30 million ha).

Water. Due to population pressure and increased livestock raising, a water crisis is being felt all over the country. Large areas of the country are still rainfed. Large areas are also experiencing drought. The continuous decline in forest cover further contributes to the change in the country's agro-climatic conditions.

The water crisis in India is also evidenced by river pollution caused by city waste and industrialization, increased demand for irrigation, and the regression of ground water level. Because of the water crisis situation, farmers find it difficult to venture into agriculture.

Air. Air constitutes 0.03 percent of total atmospheric gases. The increasing amounts of CO_2 in the atmosphere are causing an increase in temperature by 2 percent every year. High temperatures are directly influencing the patterns of atmospheric circulation, the polar ice shields at sea levels which affect precipitation and its distribution, agricultural forest productivity and CO_2 flux between the biosphere and the atmosphere. Coal burning and continuous forest destruction are also causing air pollution.

Forest cover. The world's forest cover is only 11 percent globally (app.) The Forest Survey of India (1995) estimated that forest cover from 1993 to 1995 was reduced from 64.01 to 63.96 million ha. The recorded forest area is 76.5 million ha, or 23.3 percent of the country's total geographical area. At present, the actual forest cover is estimated at 63.34 million ha or 19.27 percent of the country's land area.

India's national policy requires that forests in the hilly region should occupy 66 percent of the total forest cover and comprise 33 percent of the country's land area. Agroforestry can help provide timber and fuelwood and reduce pressure on the forests to obtain these products. A hectare of agroforestry farm could provide products equal to that of clearing 5 ha of forests.

Sustainable agriculture

Sustainable agriculture aims to meet the challenging demands for food, fiber and fuel for the burgeoning human population, fodder for animals and industrial raw materials for agro-based industries, without accelerating natural resource degradation. Sustainable agriculture and rural development conserve the natural resource base, and manage the orientation of technological and institutional change in such a way as to ensure the attainment and continued satisfaction of human needs for present and future generations. Sustainable development conserves land, water and plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable, and socially acceptable (FAO 1995). Sustainability is production with conservation.

Diversified farming system

Highly degraded areas, with slopes of more than 8 percent, have the potential for alternative land-use management systems. The system should aim at conserving the site while sustaining production.

Shifting the emphasis from commodity research towards production system research is the key to enhanced productivity, improved profitability and sustained agriculture. Diversification in farming systems minimizes risks in productivity, increases income-generating opportunities, stabilizes employment, and provides food and nutritional security. Diversity of food crops, fodder and under-utilized crops improves overall farm production and enhances soil fertility. Further, diversified farming improves on-farm conservation of plant genetic resources. Integrating livestock into the system further adds income to the farmer through the different products and provides animal power to the farmer. Tree crops integrated into the system provide shade, windbreaks, food, fodder and fuelwood.

Agroforestry

Agroforestry has the capability to fulfill both production and service roles. It can provide the basic needs of the farmer and his family, restore land productivity, reduce soil erosion and improve soil fertility.

Providing basic needs. India's population has reached one billion and is expected to increase to 1.3 billion in the next 25 years. To feed this increasing population, India aims to increase the present food grain production of 204 million tonnes to 230 million tonnes. Aside from grains, the current production of fodder falls short of demand by 60 percent. Likewise, fuelwood is in short supply. Agroforestry

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Agroforestry has the capability to provide the basic needs of the farmer and his family, restore land productivity, reduce soil erosion and improve soil fertility.

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can provide the basic needs for food, fodder and fuel through the combined production of food crops, trees and livestock in a sustainable manner.

Restoring land productivity. Alongside forest destruction is physical, chemical and biological soil degradation. Physical soil degradation includes water and wind erosion, desertification, compaction and hard setting. Chemical degradation includes acidification and sodification, while biological degradation covers the decline in organic matter and reduction in soil biological activity. The integration of tree crops in agroforestry systems helps address soil degradation and restore productivity in degraded lands.

Reducing soil erosion. Likewise, tree crops in agroforestry systems help reduce soil erosion. Tree litter intercepts sediment from surface water flow. The planting of trees as windbreaks and shelterbelts has become a common practice to protect the farm against destructive winds.

Improving soil fertility. The trees in agroforestry systems maintain and improve soil fertility. Tree litter adds organic matter and nutrients to the soil, augments biological nitrogen fixation, promotes efficient nutrient cycling and indirectly controls soil erosion. The root systems of trees add 20-30 percent organic matter and nutrients to the soil. The use of nitrogen-fixing trees further improves soil health.

The challenges being faced by farming in India can be addressed with the adoption of agroforestry systems. The integration of trees with food crops reduces competition and instead maximizes the utilization of resources for increased productivity.•

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Pongamia pinnata as an alternative source of renewable energy

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Self-reliance in addressing energy needs is a key factor in the economic progress of any developing country. Priority is given to research on renewable energy because of the increasing demand for fuel and its continuing price increases.

In recent years, research has been directed at exploring bio-fuels, which are plant-based fuel sources, to supplement or substitute fossil fuels. Bio-fuels exist in liquid forms as ethanol and bio-diesel. They are biodegradable and non-hazardous. They are gaining importance, especially in the transport sector. The use of bio-fuels also reduces the life cycle of carbon dioxide emissions, decreases dependence on petro-fuel importation, promotes rural employment, and protects the environment.

In India, consumption of petro-fuels is at 111 m tonnes annually. Of this amount, only 33 m tonnes are produced in the country as crude oil. To address the continuing need for fuel and at the same time fodder, timber, and various forest products in India, research on *Pongamia pinnata* seeds is being done to explore its potential for producing bio-diesel.

Species profile

Pongamia pinnata is a moderately-sized evergreen tree with a spreading crown and a short bole. It belongs to the family Leguminaceae (Papilionoideae) and is commonly known as *karanj*. It is an Indo-Malaysian species that survives at 1200 m asl. It is common along alluvial and coastal areas, from India to Fiji. The species thrives in areas with an annual rainfall of 500-2500 mm, and a temperature range of 1-38 ^{0}C. It can resist drought and withstand water logging and slight frost.

Karanj is a fast-growing, glabrous and deciduous tree with grey smooth bark. Flowers are colored white and pink and known for their fragrance. Pods measure 40-60 mm long and 20-30 mm wide, are thick-walled, and usually contain a single seed. Seeds are 17-25 mm long, oblong, and light brown in color. The tree species is now found in Australia, Florida, Hawaii, India, Malaysia, Oceania, Philippines and Seychelles.

Pongamia pinnata is one of the few nitrogen-fixing trees to produce seeds that contain 30-45 percent oil. The oil is thick and yellow-orange to brown in color. The oil is

The pods of Pongamia pinnata.

The seeds of Pongamia pinnata.

used as a substitute for diesel fuel. Further, the oil is being promoted as a lubricant, water-paint binder, pesticide, one of the raw materials for soap, and in tanning.

In agroforestry, karanj can be integrated with agricultural crops only on saline soils at 6 m x 6 m spacing. It can be planted along boundaries or along the road at 5 m x 5 m spacing. About 110 plants can be planted per acre at 6 m x 6 m spacing.

Karanj produces seeds starting from its fourth year. It can yield 10 kg of seeds during its initial years. A medium-sized *karanj* can yield 25- 40 kg of seeds per year and later on 50 kg of seeds. Seeds can be collected during April-June. Normally, a person can collect 30 kg of seeds/day which are sold for Rs.3 per kg (USD0.061) in India.

Further research on the integration of *karanj* as a bio-fuel crop in agroforestry systems is recommended to help promote its use as renewable energy.•

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Park plantation of Pongamia pinnata.

Pongamia pinnata planted along road sides.

Pongamia pinnata - based agroforestry system.

Planet under pressure

To be held 26-29 March 2012, in London, U.K., the *International planet under pressure* conference will provide a comprehensive update of the pressure that planet Earth is now under. The conference will discuss solutions at all scales to move societies on to a sustainable pathway. It will provide scientific leadership towards the 2012 UN Conference on Sustainable Development - Rio+20.

Key Aims

The conference aims to achieve the following:

- A state of the planet assessment and solutions for a sustainable future;
- Gather 2 500 participants combining global-change science and policy, business and development communities;
- Scientific leadership towards the 2012 UN Rio +20 conference;
- Building trans-disciplinary research communities;
- Identifying opportunities for enhanced partnerships between global change science; and policy, industry and the public
- A new vision for international research.

Conference Themes

Three broad themes will guide the conference:

- Meeting global needs: food, energy, water and other ecosystem services;
- Transforming our way of living: development pathways under global environmental change; and
- Governing across scales: innovative stewardship of the Earth system.

For more information: http://www.planetunderpressure2012.net.•

International conference on climate adaptation 2012

The *Climate adaptation futures 2012* conference, to be held 29-31 May 2012, in Tuscon, Arizona, U.S.A., will focus on adaptation to climate variability and change. It will bring together researchers, policy makers, and practitioners from developed and developing countries to share insights into the challenges and opportunities that adaptation presents. It will showcase cutting-edge research from around the world, focusing on themes of equity and risk, learning, capacity building, methodology, and adaptation finance and investment. It will explore practical adaptation policies and approaches, and share strategies for decision making from the international to the local scale.

High-priority topics and questions include:

- Regional studies: Where are the places and people most at need? What are their adaptation options and strategies for implementation?
- Update on key emerging climate change and impacts science, including the latest on future extremes, sea level change, water supplies and landscape transformation: How will uncertainties change in the coming decade?
- Communicating climate risks to facilitate adaptation: What do people want and need to know and how best to understand and deliver information?
- Building adaptive capacity: Communities, institutions, and individuals lack sufficient capacity for implementation; What are the most effective ways to build capacity? What type of investments in capacity are appropriate and what scale of decision-making should be targeted?
- Examples of adaptations through case studies and best practices, including costs and benefits of implementing these options: What can we learn from past adaptations to environmental change? How can we foster adaptations to futures characterized by surprise, non-linear change and unexpected consequences?
- Funding priority research and adaptation: Who pays, and for what, where, and how?
- Tools for adaptation: What approaches, tools, and methods are available? How do we judge their effectiveness?
- Measuring and evaluating adaptation: How do we know whether investments in adaptive capacity and adaptation are working?
- Adaptation under 4 degrees Celsius warming: As mitigation options are exhausted or delayed how might we face the challenges of adapting to 4°C of warming?

For more information contact University of Arizona Institute of Environment via e-mail or phone: +1 (520) 626-4345. For more information, visit http://www.adaptation.arizona.edu/adaptation2012.•

New information resources

Agrobiodiversity management for food security

Agrobiodiversity provides most of our food through our interaction with crops and domestic animals. Future global food security is firmly anchored in sound, science-based management of agrobiodiversity. Written by J. M. Lenné and D. Wood, this book presents key concepts of agrobiodiversity management, critically reviewing important current and emerging issues including agricultural development, crop introduction, practical diversity in farming systems, impact of modern crop varieties and GM crops, conservation, climate change, food sovereignty and policies. It also addresses claims and misinformation in the subject based on sound scientific principles. Available: http://bookshop.cabi.org.

Agroforestry systems journal

Agroforestry systems is a peer-reviewed international scientific journal presenting original research results, critical reviews and short communications on all aspects of agroforestry, including both biophysical and socioeconomic aspects. Short communications typically report on incomplete or initial results. The journal also periodically publishes book reviews and other professional information. Coverage includes investigations of a fundamental or applied nature, research methodologies and techniques, and analytical descriptions of little-studied but potentially promising agroforestry and other integrated systems involving trees and crops and/or livestock. The editors choose for publication articles relevant to a broader context than the specific location of the study that provide new insight or significant contributions to the knowledge base. Available: http://www.springer.com/.

Building resilience to climate change: ecosystem-based adaptation and lessons from the field

With climate change now a certainty, the question is now how much change there will be and what can be done about it. One of the answers is through adaptation. Many of the lessons that are being learned in adaptation are from success stories from the field. This publication contains 11 case studies covering different ecosystems and regions around the world. It aims to summarize some current applications of the Ecosystem-based Adaptation (EbA) concept and its tools used around the world, and also draw lessons from experiences in conservation adaptation. Available: http://www.earthprint.com/.

Bundles of energy: the case for renewable biomass energy

This report aims to inform forest and energy decision makers in non-OECD countries of key issues surrounding the biomass energy boom. It describes the advantages and challenges of biomass, how it compares with renewable alternatives, and how to develop policy frameworks that optimize its impact on poverty reduction, climate change mitigation and the preservation of ecosystem services. It seeks to stimulate interest in the topic and promote serious discussion about how the full potential of biomass energy can be harnessed in the service of national interests. Available: http://www.earthprint.com/.

Climate change, water and food security

The impacts of climate change on the global hydrological cycle are expected to vary the patterns of demand and supply of water for agriculture - the dominant use of freshwater. This report summarizes knowledge of the anticipated impacts of climate change on water availability for agriculture and examines the implications for local and national food security. It analyses the expected impact of climate change on a set of major agricultural systems at risk and makes the case for immediate implementation of "no-regrets" strategies which have both positive development outcomes and make agricultural systems resilient. It is hoped that policy makers and planners can use this report to frame their adaptation responses when considering both the water variable in agriculture and the competing demands from other users. Available: http://www.fao.org/.

Collaborative governance of tropical landscapes

This book provides a novel approach to governance relating to biodiversity and human well-being in complex tropical landscapes, including forests and protected areas. It focuses attention at the interface between communities and the landscape level, building on interdisciplinary research conducted in five countries (Cameroon, Indonesia, Lao PDR, Madagascar and Tanzania). In each country, the research was set within the framework of a major national policy thrust. The book improves our understanding of and ability to manage complex landscapes---mosaics of differing land uses—in a more adaptive and collaborative way that benefits both the environment and local communities. It includes both single country and cross-site analyses, and focuses on themes, such as resettlement, land use planning, non-timber forest product use and management, the disconnect between customary and formal legal systems, and the role of larger scale policies in local level realities. Chapters also analyze experience with monitoring and a local governance assessment tool. Available: http://www.earthprint.com/.

Crop stress management and global climate change

Climate change is a diverse, multifactorial phenomenon, meaning that the agronomic strategies needed are case-specific and will have regional differences. This book provides an integrated view of the challenges and opportunities that will face agriculture in the future as a result of climate change. It discusses how the stresses resulting from climate change can be overcome by assessing, measuring and predicting environmental changes and stresses, identifying opportunities and adapting to change and responding to multifactorial change. Challenges and potential strategies that might be taken to overcome these are illustrated using a number of case studies. This book is edited by J. L. Araus. Available: http://bookshop.cabi.org/.

Food security and global environmental change

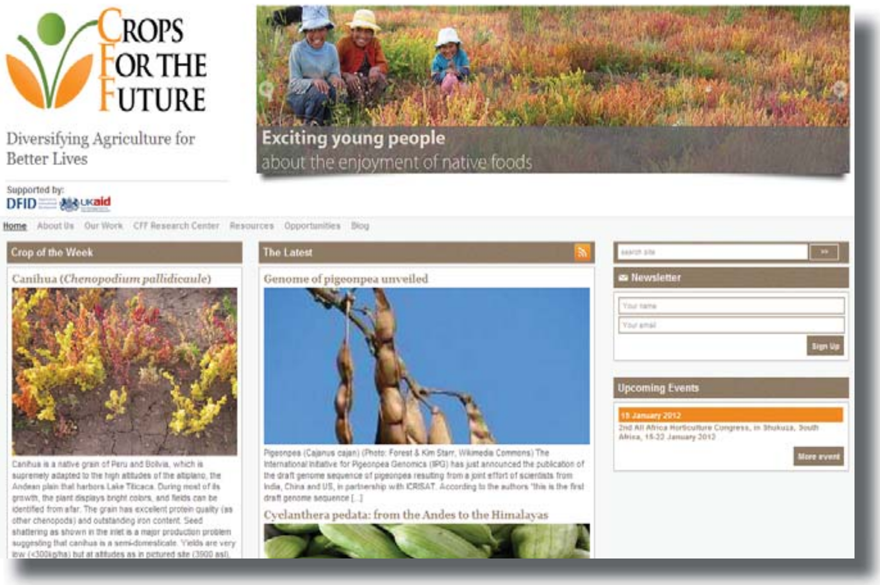
Global environmental change (GEC) represents an immediate and unprecedented threat to the food security of hundreds of millions of people, especially those who depend on small-scale agriculture for their livelihoods. The book provides a major, accessible synthesis of the current state of knowledge and thinking on the relationships between global environmental change and food security. Information shows that agriculture and related activities also contribute to GEC by, for example, intensifying greenhouse gas emissions and altering the land surface. Responses aimed at adapting to GEC may have negative consequences for food security, just as measures taken to increase food security may exacerbate GEC. The authors show that this complex and dynamic relationship between GEC and food security is also influenced by additional factors; food systems are heavily influenced by socioeconomic conditions, which in turn are affected by multiple processes such as macro-level economic policies, political conflicts and other important drivers. Available: http://www.earthprint.com/.•

Useful websites

Crops for the future

http://www.cropsforthefuture.org/

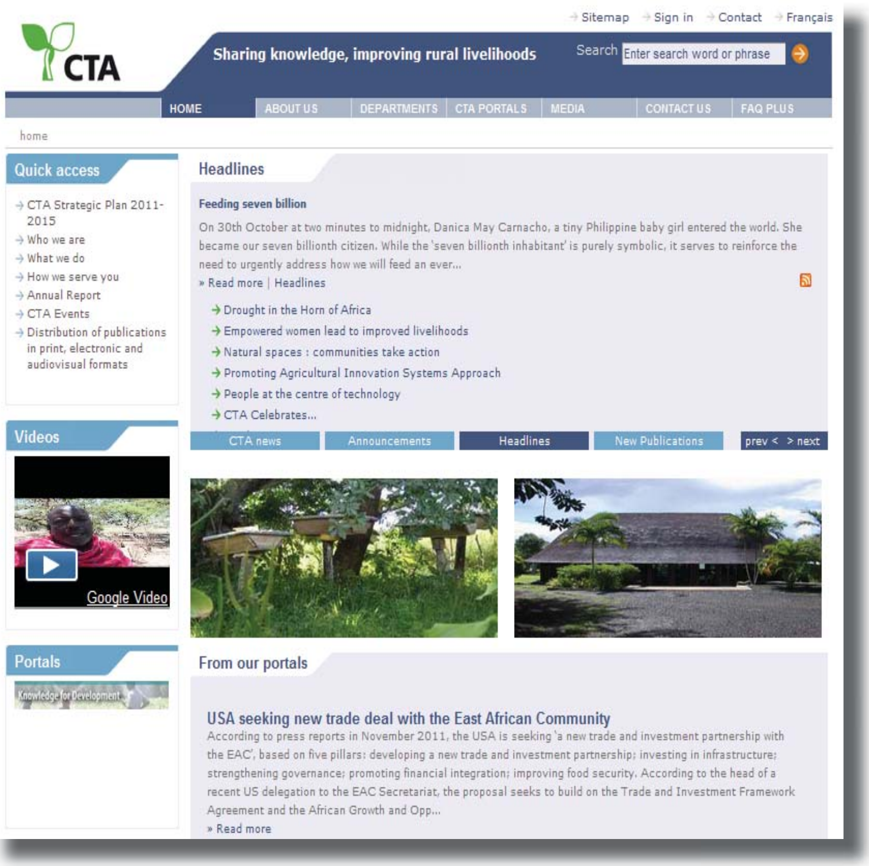
Crops for the Future is an organization dedicated to the promotion of neglected and underutilised plant species as a contribution to humanity. Activities are arranged in three major strategic objectives formulated to increase the impact of past and ongoing research and development: (1) increasing the knowledge base for underutilised crops, especially regarding sustained market access, nutritional security, health and climate change; (2) identifying and advocating necessary policy change to promote the use of underutilised crops; and (3) fostering capacity building about underutilised crops.

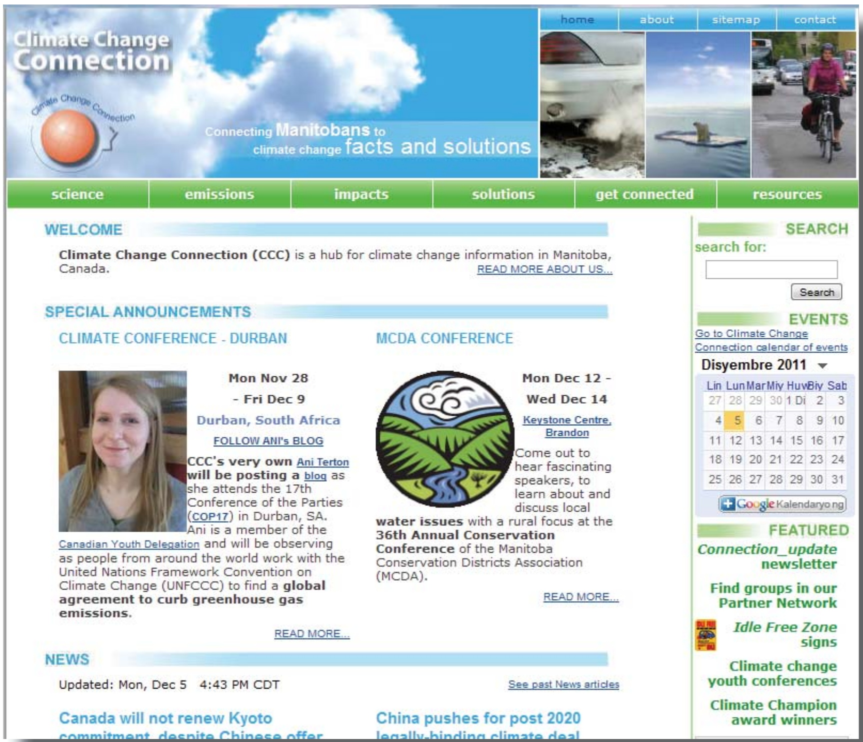


The Technical Centre for Agricultural and Rural Cooperation

http://www.cta.int/

The Technical Centre for Agricultural and Rural Cooperation (CTA) works in the field of information for development. Focus is on: (1) providing information products and services (e.g., publications, question-and-answer services and database services); (2) promoting the integrated use of communication channels, old and new, to improve the flow of information (e.g., e-communities, web portals, seminars, and study visits); and (3) building capacity in information and communication management, mainly through training and partnerships.





Climate Change Connection

http://www.climatechangeconnection.org/Solutions/Agroforestry.htm

Climate Change Connection has an educational and facilitative role toward climate change solutions. The network facilitates sharing of toolkits, presentations, website resources, network lists, funding guides and calendar, workshops, campaign initiatives, library resources, and various displays.

National Sustainable Agriculture Information Service

http://attra.ncat.org/index.php

The National Center for Appropriate Technology is a private nonprofit organization, founded in 1976, which operates a series of publicly-funded projects to promote self-reliance (especially for low-income people) through wise use of appropriate technology. Its programs deal with energy conservation, resource-efficient housing, sustainable community development, and sustainable agriculture.

Call for Contributions

We are inviting contributions for the 40th and 41st issues of the Asia-Pacific Agroforestry Newsletter (APANews) on or before 28 February and 30 June 2012, respectively.

Contributions may focus on activities that highlight agroforestry research, promotion and development, and education and training.

Topics of particular interest are on:

- agroforestry and poverty alleviation;
- agroforestry and livelihood;
- agroforestry and farmers' income and livelihood;
- agroforestry enterprises and/or marketing
- agroforestry and mining area rehabilitation;
- agroforestry and climate change;
- agroforestry and biodiversity conservation;
- agroforestry and desertification; and
- other key development issues in agroforestry.

Announcements on new information resources, useful websites, and upcoming relevant events are also welcome.

Interested contributors must keep the articles straight and simple to cater to as many audiences as possible. Limit your contributions to 1 000 to 1 500 words. Include good-quality photographs (scanned at 300 dpi) that are properly labeled and referred to in the text. Indicate your complete contact details, especially your E-mail address in the article, for readers to contact you should they have further inquiries about your article.

Send your contributions through E-mail to the UPLB Institute of Agroforestry, 2/F Tamesis Hall, College of Forestry and Natural Resources, UP Los Baños, PO Box 35023, College, 4031 Laguna, Philippines; Fax +63 49 5363809; E-mail fao_apanews@yahoo.com and apanews0718@gmail.com.•

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