

**ASIA-PACIFIC
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Featuring
SEANAPE News



Dear readers

We bring you the last issue of APANews for 2008 with a very interesting line-up of articles for agroforestry research, promotion and development, and education and training. Asia-Pacific is indeed well-represented as we feature articles from Cambodia, India, Indonesia, the Philippines, Sudan and the US.

The article from Cambodia discusses the findings of a research that integrates multipurpose tree species (MPTS) in the country's farming systems. Read more on the products and services that could be obtained by integrating MPTS in home gardens, rice fields and livestock raising.

An article from India, meanwhile, discusses the capability of agroforestry systems to thrive in rainfed, semi-arid, sub-tropical regions by presenting the costs and returns of various combinations of trees and understorey crops. Find out how agroforestry was able to adapt to the conditions of this region.

In Indonesia, meanwhile, a research explored the impacts of alley cropping on the productivity of former pumice-mined lands. The findings of this

research attest to the capability of agroforestry in rehabilitating previously mined areas.

Our first contribution from Sudan presents the findings of a research that explored the capability of agroforestry to cope and/or rehabilitate areas suffering from desertification.

Desertification is considered a serious threat to land productivity as it destroys biological resources, thus making the land conditions similar to that of a desert. Read more on the findings of a series of experiments implemented in a span of three years.

A very significant article from the US discusses the role of windbreaks in saving the agricultural sector in Florida, especially the vegetable and citrus farming industries. Find out more about the benefits derived from windbreaks, the extent of their effectiveness, and how they can be effectively established. Various lessons and insights can be gained from this article which can be applied in agroforestry farms.

In the field of agroforestry education, an article from the Philippines highlights how a state university was

able to successfully build and strengthen the entrepreneurial skills of their agroforestry students/ graduates. Their experiences may inspire other schools that are offering similar agroforestry entrepreneurship programs.

Also, find out the latest activities and initiatives of the Southeast Asian Network for Agroforestry Education (SEANAFE) in our featured SEANAFE News. This issue highlights the results of the network's 16th Board meeting, the next batch of MS Research Fellowship grantees, training initiatives, special projects by the country networks, and the launching of the network's forestry policy project, among other updates.

We continue to feature announcements of upcoming events, relevant websites, and new information resources that may be of use in your various agroforestry initiatives.

We hope you enjoy reading this issue as we have enjoyed producing it. Again, thank you to all the contributors and we hope to receive more interesting articles from you in the future! – **The Editors**

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COVER PHOTO. A research initiative in Prey Veng Province, Cambodia explores the integration of *Leucaena leucocephala* and other multipurpose trees in the rice fields, home gardens and livestock raising of farmers. Findings show that multipurpose trees help diversify traditional agroforestry practices in Cambodia, thereby improving and maximizing farm productivity, and producing various products and services that provide for the basic needs of the farmer and his family. (see story on page 12).

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Studying the potentials of agroforestry in coping with desertification in Northern Sudan

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The northern region of Sudan is viable for producing a number of food crops such as wheat, faba bean, fruits and some spices. However, desertification is the greatest threat to the development of agriculture as it causes the continuous reduction of arable land. Desertification is the destruction of the land's biological resources which can ultimately lead to desert-like conditions.

Aside from desertification, encroachment is also threatening the agricultural resource base of the land, including the livelihood and survival of the people and their communities. In several areas of the region, desert encroachments are threatening the Nile course itself (Figure 1).

Trees and alley cropping

Trees are important in sustaining farm productivity. They protect the crops, help improve the microclimate, and provide local communities with various products and services. However, land scarcity and the high cost of irrigation restrict the plantation of pure tree stands in Northern Sudan. There is also lack of short-term incentives for people while the trees are young and not yet commercially viable. This situation discourages community participation which is the basis for ensuring sustainability and management of afforestation activities.

In contrast to pure tree stands, the alley cropping system is considered an alternative option that can

reconcile the needs of the farmers for crops and trees. Alley cropping establishes trees and shrubs as hedgerows with food crops cultivated in the alleys between the hedgerows. This type of agroforestry system has been proven to achieve high and sustainable production of food crops, and tree products and services, and at the same time protect the land against desertification.

Identifying suitable tree species

Successful afforestation relies on the careful selection of suitable tree species. Mesquite (*Prosopis chilensis*) was found to be the most suitable tree species for Northern Sudan. It is a fast-growing tree, has the ability for drought-nitrogen fixation, and provides fuelwood and fodder.

However, Sudanese farmers are wary of planting mesquite because it can spread rapidly and become a noxious weed. It blocks irrigation canals and competes with the commercially viable crops (Figure 2). Once a weed, mesquite is difficult to eradicate.

The Agricultural Research Corporation (ARC) in Sudan identified suitable tree species that possess similar desirable attributes as that of mesquite but do not behave as weeds. The tree species identified were two Australian acacias, namely: *Acacia ampliceps* and *Acacia stenophylla*. They are considered multipurpose, fast-growing and nitrogen-fixing trees. They are thornless and can produce fodder.

The two tree species were tested in a comparative study with *Prosopis chilensis* (mesquite). Results showed that *A. ampliceps* performed better than the other two species in terms of tree volume and biomass production (Figure 3).

A. ampliceps was found to be drought-resistant and require moderate amounts of water. On the other hand, *A. stenophylla* proved superior to *A. ampliceps* in terms of drought-tolerance. It was able to survive the dry season of Northern Sudan which is more than seven months. It has an open canopy and the dried pods were found effective as insect repellent. These characteristics proved that the two Australian acacia were successful candidates for integration in agroforestry farms established in harsh and dry conditions.

Moreover, the growth habit and morphology of these two trees permit the cultivation of understory crops.

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Fig. 1. Desert encroachment threatens the Nile course.



Fig. 2. Mesquite trees invade arable land

Studying the potentials...

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The two species also produce high organic matter.

In addition, the juvenile, air-dry leaves and leaf litter of *Acacia ampliceps* are grazed by different animals. It has a very high potential for fodder production, especially during lean periods of the year. However, as the



Fig. 3. The yields of *A. ampliceps* are higher as compared to *A. stenophylla* and *P. chillensis*.



Fig. 4. *A. ampliceps* can be a substitute for mesquite in terms of biomass production.

tree becomes older, animals find the leaves less palatable.

The two trees were then tested on the field to gauge their adaptability and suitability to different forms of afforestation. ARC released *A. ampliceps* in 1998 for biomass production and as a substitute for mesquite under irrigation (Figure 4). *A. stenophylla* was also released by ARC in the same year for integration in farms that have been established in areas suffering from drought and water shortage (Figure 5).

Three-year series of experiments

To help cope with desertification, a study was conducted between 1998 and 2000 to determine the effect of alley cropping on the productivity of different agricultural crops. The experiments also investigated the potential of an alley cropping system (6-m wide) to exploit residual water in the surface horizons and beyond the rooting depth of the associated crops (Figure 6).

The study site was established at the Hudieba Research Station (HRS), 300 km north of Khartoum, Sudan (17.57°N and 33.8° E). The site lies within the desert to semi-desert regions of Northern Sudan and has a mean annual rainfall of 0-150 mm. The summer season was characterized by high solar radiation, air temperatures, and wind speed but with low relative humidity. May and June were the hottest months with a mean daily maximum temperature of 42°C. Such harsh conditions limited the people from venturing into summer farming.



Fig. 5. *A. stenophylla* has an open canopy and deep roots.

In addition, the soil in the study site was generally alkaline (pH 7.8–8.4). The soil was non-saline and non-sodic with very low organic carbon (less than 0.1%). The soil texture at the top 30 cm of the soil was loamy sand. The amount of clay was found to increase (40%) with increasing soil depth (60–120 cm). The amount of Ca CO₃ also increased as soil depth increased. The soil belonged to the Aridisols order and had reasonably high water-holding capacity.

Evaluating potentials and performance

Three nitrogen-fixing trees were used as hedgerows, namely: *Acacia ampliceps*, *Acacia stenophylla* and *Leucaena leucocephala*. Changes in the alley cropping microclimate were quantified and analyzed in relation to plant responses and the growth of all system components. Aboveground interactions were also examined by installing a series of weather stations in the different zones of the alleys, and establishing control plots for monitoring microclimatic changes.

Results revealed that substantial amounts of wind speed and radiation were reduced. There were slight reductions in the air temperatures, and significant increases in the relative humidity and soil moisture in the alleys. In addition, there were complex interactions and extensive overlaps between different climatic factors, and efficient use of water by the system itself.

During the winter seasons of 1999 to 2000, the average yields of wheat, faba bean and common bean planted in the alleys increased by 69 percent, 15 percent and 10 percent, respectively.

During the autumn season of 2000, the yield of groundnut planted in the *A. stenophylla* and *A. ampliceps* alleys increased by 37.7 percent and 19.6 percent, respectively. The yield of sesame increased in the *A. stenophylla* alley (+40.3%), while it decreased in the *A. ampliceps* alley (-51.5%).

During the summer of 2000, the yield of carrot increased by 487 percent. Reduced solar energy during this time was advantageous to off-season crops. The yield of sweet pepper also increased as it produced 5 833 kg per hectare of fresh fruit. In addition, results of the tree-water-use interaction showed that the tree species differed in their abilities to extract water from the different soil horizons. This was due to the differences in the trees' growth and competitive interactions. The

A. stenophylla tree, with its deep roots and open canopy, was found to be capable of saving most of the irrigation water. The most water saved by *A. stenophylla* occurred in June.

Conclusions

The results of these researches showed that *A. stenophylla* can be integrated in alley cropping systems in Northern Sudan to combat desertification. The behavioral characteristics and growth habits of this tree were found highly suitable in the country's harsh conditions.

A. stenophylla not only improves microclimatic conditions but also transmits sufficient amounts of light through its canopy to promote the growth of understorey crops. It can also extract water from levels beyond the root zone of agricultural crops (below 60-cm deep), thus utilizing the water in the alley cropping system efficiently. More importantly, it can help increase the yields of crops under semi-desert conditions. This capability addresses the utmost concern of the people in the country – survival. ■ *The author works at the Agricultural Research Corporation, Box 126, Wad Medani, Sudan, Africa.*

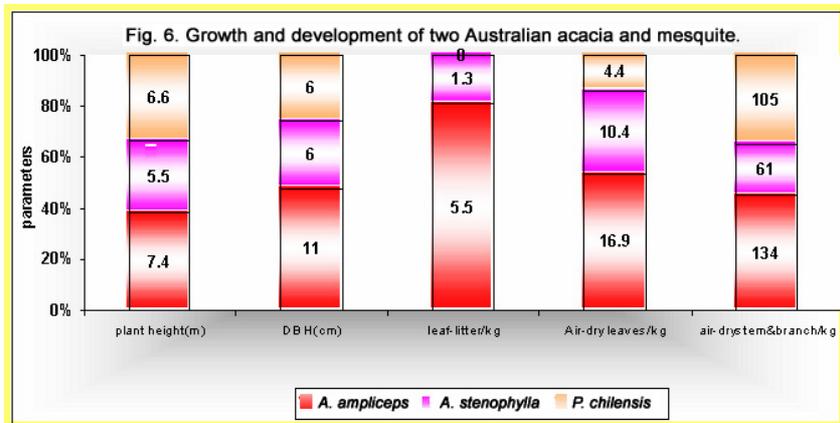


Fig. 6. The potential of alley cropping using *A. ampliceps* is measured in terms of height, DBH, leaf litter, air-dried stems and branches.

Using alley cropping to rehabilitate reclaimed pumice-mined land in Indonesia

Budi Hadi Narendra (budihadin@yahoo.co.id)

Pumice is a type of igneous rock which is formed when lava cools quickly during eruptions. Pumice rocks are so light that they can actually float on water. They are often used as decorative stones in landscaping, and as abrasives in polish cleanser compounds and even soaps.

Pumice mining and its impacts

People collect pumice through surface mining activities. Pumice

mining is traditionally done by digging holes at 5-7 m deep. Miners create new holes to dig if they cannot find pumice in previously dug holes. This type of mining causes the topsoil to drift, especially during the rainy season (Figure 1).

Pumice is mined in hilly areas, particularly during the rainy season. Miners cut the slope and sweep away the material using irrigation water (Figure 2). Miners then trap and collect the pumice. This practice

causes the loss of topsoil by water flow. As a result, irrigation water becomes turbid.

The district of Lombok Timur in the eastern part of Lombok island is known for its pumice mining. Production reached 7 568 982 m³ from the spread of Selong, Masbagik, Sikur, and Sukamulia sub-districts.

Pumice mining has reduced soil fertility and thereby limits the crops that can be planted. Moreover, the low rainfall in the area further constrains people from farming reclaimed pumice-mined lands. In fact, reclamation of pumice-mined lands is very rarely done due to the lack of technology to effectively regain its productivity.

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Using alley cropping...

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Exploring the potential of alley cropping

From 2004 to 2006, a research was conducted to explore the effectiveness of alley cropping in improving the soil properties of a reclaimed pumice-mined land in the district of Lombok Timur. The trial used some leguminous tree species as hedgerows and manure as additional input. Alley cropping was chosen for its ability to improve soil properties, reduce chemical fertilizer inputs, and provide both short- and long-term benefits.

Designing the trial

The reclaimed pumice-mined land had a Regosol soil type with 10 YR 3/3 color, sandy loam with medium to coarse texture, pH 6.8, and very low organic matter (0.83%). The area is located 100 m asl and has a 15-degree slope. Annual average rainfall is 519 mm per year (BRLKT Wilayah VII 1987).

The trial used the completely nested randomized block design. Teak (*Tectona grandis*) and mangoes



Fig.1. People mine pumice by digging holes.



Fig.2. Mining of pumice is done by cutting the slope and using flowing irrigation water.

(*Mangifera indica*) were used as the main trees of the system. Three leguminous species were used as treatments – leucaena (*Leucaena leucocephala*), sesbania (*Sesbania grandiflora*), and gliricidia (*Gliricidia sepium*). Each plot used centrosema (*Centrosema pubescens*) as cover crop during the dry season. Manure (4.4 kg/m²) was applied to all the crops.

During the rainy season, centrosema was replaced with groundnut and maize. Teak and mangoes were planted using 3 m x 4 m spacing, while 3-m spacing was used between hedgerows. The legumes and hedgerows were planted 0.5 m apart (Figure 3).

Obtaining multiple benefits

High growth rate of species.

Converting the reclaimed pumice-mined land into an alley cropping system was successful. Each species showed very high survival rates (>90%) six months after planting. All the seedlings of teak, leucaena and sesbania survived. The high survival rate demonstrated the high adaptability of the species to the area's climate and soil conditions. Centrosema showed high growth rate – growing to 50-cm thick and completely covering the soil surface. Centrosema is a shade-tolerant species that grows well under dense canopy because of its deep rooting system (Figure 4).

High amounts of green manure.

The prunings from the different legumes were weighed and used as green manure. Among the three leguminous tree species, sesbania had the highest leaf weight (4.5 ton/ha) during the first year of the trial. Gliricidia, meanwhile, had the

highest leaf weight (8.6 tons/ha) during the second year.

The total weight of all the prunings was 41.4 tons per hectare and 45.1 tons per hectare in the first and second year, respectively. It was assumed that this amount contributes 1 percent nitrogen and 0.1 percent phosphorous to the soil, similar to that of 207 kg of urea fertilizer and 22 kg of phosphate fertilizer, respectively.

High quality forage. Aside from being used as green manure, the prunings could also be used as forage. The dry leaves contained high protein content of up to 27 percent.

In the trial, leucaena had the lowest dry weight (1.6 and 6.0 ton/ha) among the leguminous tree species.

Leucaena has balanced amounts of protein, minerals, and amino acids and is low in both crude fiber and tannin content. These characteristics make leucaena a high quality forage (Panjaitan 2004). Leucaena also has high coppicing ability and its wood can be used as fuelwood.

During the dry season of the first year, centrosema supplied 31.5 tons per hectare of fresh weight forage. This amount can support 35 young cows for six months assuming that a young cow weighs 100 kg and consumes fresh weight forage of as much as 5 percent of its body weight daily.

In the second year, when sesbania, gliricidia and leucaena prunings showed increasing weight, centrosema slightly decreased to 2.3 tons per hectare. This decrease in weight could be the result of increased shading due to the denser

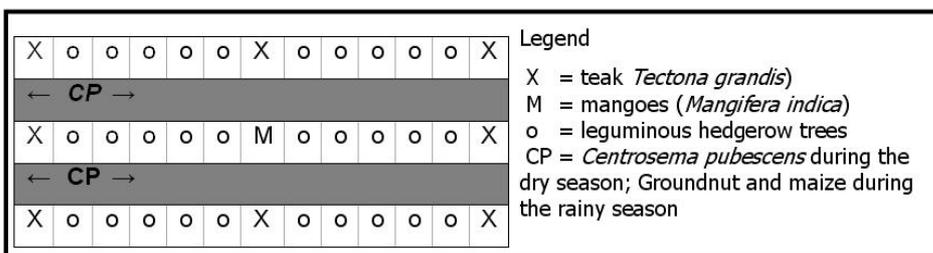


Fig. 3. Layout and species composition of the trial plots.

canopies of the three leguminous tree species in the second year.

High crop harvests. In the rainy season, groundnut and maize were planted in the alleys between the leguminous trees. These species replaced centrosema as the cover crop (Figure 5).

Groundnut and maize harvests were weighed (Table 1). Results showed that groundnut obtained the highest weight (1.3 ton/ha) when planted in the alleys between the sesbania hedgerows. Meanwhile, maize obtained the highest weight (2.5 tons per hectare) when planted in between the leucaena hedgerows.

These results were obtained after manure and green manure were applied. According to Purwono (2005), successive planting of groundnut and maize can obtain harvests of 1.2-2 tons per hectare and 2 tons per hectare, respectively.

The growth of teak and mangoes, meanwhile, did not show significant changes in their normal growth rate.

Improved soil properties. Two years after establishing the alley cropping system, soil analysis revealed increased organic matter, total nitrogen, and available phosphorous, potassium, calcium and magnesium in the soil. The increased soil organic matter also improved soil structure, porosity, permeability, cation exchange capacity, and water-holding capacity.

These results showed that alley cropping, with leguminous trees as hedgerows, has the ability to improve the soil properties of former pumice-mined lands. Improved soil properties pave the way for increased land productivity and consequently provide local people with alternative sources of livelihood. More importantly, the trial demonstrated the capability of the alley cropping system to rehabilitate lands whose resources have been depleted by mining. ■ *The author is a researcher at the Mataram Forestry Research Institute, Jalan Dharma Bakti no. 7 Desa Langko, Kecamatan Lingsar, Lombok Barat - NTB - Indonesia.*

References: 1) BRLKT Wilayah VII. 1987. Rencana Teknik Lapangan Rehabilitasi Lahan dan Konservasi Tanah Sub DAS Menanga. Mataram.; 2) Panjaitan, T. S. 2004.



Fig. 4. *Centrosema (Centrosema pubescens)* under the seedlings of *gliricidia (Gliricidia sepium)* and teak (*Tectona grandis*).



Fig. 5. Groundnut and maize are planted in the alleys between the *sesbania* hedgerows.

Mengenal Potensi Lamtoro Hibrida F1 (KX2) sebagai Sumber Pakan Ternak. BPTP NTB, Mataram; 3) Purwono. 2005. Bertanam Jagung Unggul. Penebar Swadaya. Jakarta.

Sustaining farm productivity through windbreaks

Bijay Tamang (bijay@ufl.edu), Michael G. Andreu and Donald L. Rockwood

Windbreaks are vertical structures that impede wind flow. They can be living or non-living based on the material used.

Living windbreaks consist of plants (usually trees), whereas non-living windbreaks are often structures made from a variety of non-living materials including metal and plastic cloth. Both types of windbreaks can potentially provide the same functions, but while living windbreaks take longer to establish, they are comparatively cheaper than non-living windbreaks.

Aside from impeding wind flow, windbreaks offer other benefits. If well-designed and appropriately positioned, windbreaks can increase crop and livestock production, reduce soil erosion, improve microclimates, increase irrigation efficiency, control the spread of pathogens, reduce energy cost, and serve as wildlife habitat and buffer strips (both for water quality and pesticide drift). They can also act as screens against undesirable sights and add aesthetic value to the landscape. Windbreaks can generate most of these benefits simply by reducing wind speed thus modifying the microclimate.

Challenges to Florida's vegetable and citrus farming

Vegetables and citrus are the major farm products of Florida. As of 2006, both products were exported to other states in the US and to as many as 140 countries. Recently, however, the industry is suffering from adverse conditions and diseases especially among citrus species.

One element that contributes to adverse farming environments is wind. Regular sea breeze as well as seasonal wind events, associated with tropical storms and hurricanes, often cause soil erosion. As a result, large amounts of nutrients are lost along with the eroded soil.

Soil erosion is one of the major agricultural problems around the world that depletes soil fertility in the

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topsoil. Studies show that the nutrient level in wind-transported soil is higher than in the remaining topsoil (Nuberg 1998 and Sudmeyer and Scott 2002). In the long term, erosion of nutrient-rich soil particles will seriously deplete soil fertility and increase production cost. Large soil particles, such as sand, carried by winds, also cause physical abrasions to vegetables and fruits, thereby reducing their quality.

Aside from destructive winds and soil erosion, diseases are also threatening Florida's citrus industry. Wind and rain splashes disperse citrus canker within the grove and between groves (Gottwald et al. 1992, and Graham and Gottwald 1992). Citrus canker is a disease caused by bacteria that spreads among citrus plants. Rain facilitates canker spread as bacteria can ooze onto the surface of the infected leaves and fruits when canker lesions are wet. The spread of canker intensifies during events such as hurricanes.



Fig. 1. A single row of 20-year-old cadaghi windbreak at C&B Farms near Clewiston, Florida (with 20% porosity).



Fig. 2. A single row of 20-year-old eastern redcedar windbreak at the Southwest Florida Research and Education Center (SWFREC), Immokalee, Florida (with 17% porosity).

Citrus canker is one of the major diseases that can be controlled through windbreaks. Windbreaks have been successfully applied to control canker spread in Argentina since the 1970s (Leite and Mohan 1990). Research indicates that windbreaks reduce both temporal and spatial spread of canker more effectively than Copper (Cu) bactericide, a standard method widely used for canker control (Gottwald and Timmer 1995).

The spread of canker during the 2004-2005 hurricane seasons damaged the citrus industry of Florida. Some experts have indicated that the industry may not return to the production level prior to the 2004-2005 hurricane events due to extensive canker spread.

Windbreaks in Florida

Sustained high-speed winds, frequent hurricanes and increasing canker incidences have encouraged the establishment of windbreaks in Florida. Efforts are underway to establish windbreaks using fast-growing evergreen species for year-round protection. Citrus growers are now particularly showing interest in windbreak establishment.

A recent study evaluated cadaghi (*Corymbia torelliana*) windbreaks at the C&B Farms near Clewiston, and eastern redcedar (*Juniperus virginiana*) windbreaks at the Southwest Florida Research and Education Center (SWFREC), University of Florida in Immokalee. C&B Farms have established cadaghi windbreaks at various ages. The oldest cadaghi windbreak was established in 1988. It is now 18 m (59 ft) tall (Figure 1). Its porosity is approximately 20 percent. The redcedar windbreak planted in the same year is seven meters (23 ft) tall and has a porosity of approximately 17 percent (Figure 2). From this study, researchers identified the most important variables that modified microclimates around windbreaks.

Microclimate modification by windbreaks

Results indicated that wind speed reduction in the protected areas varied depending on tree porosity and distance from windbreaks. Figure 3 compares relative wind speeds depending on the direction of the wind (when wind direction was nearly perpendicular or parallel to the windbreak) in the protected area behind the dense eastern redcedar windbreak, at the same location as that of Figure 2. The windbreak was most effective when wind direction was nearly perpendicular to the windbreak. Its effectiveness decreased as the wind approached a parallel direction to the windbreak. Regardless of wind direction, the lowest wind speeds recorded were at a distance of two times the height of the windbreak (2H). Beyond that point, wind speed gradually increased. At a distance of 14H, wind speed behind the windbreak was lower than the wind speed in the open area. This was most pronounced when wind direction was nearly perpendicular (56% versus 92%) to the windbreak.

In contrast to the dense redcedar windbreak, Figure 4 illustrates relative wind speeds in the protected area behind a relatively porous cadaghi windbreak. Like the redcedar windbreak, lower wind speeds were observed behind the cadaghi windbreak at closer distances (2H and 6H), when wind direction was nearly perpendicular to the windbreak. Wind speed gradually increased up to 14H and decreased again at 16H as it approached the second windbreak. Maximum wind speed reduction in the protected area was approximately 72 percent of the open wind speed versus 97 percent behind the dense windbreak when the wind was nearly perpendicular. However, in both cases, relative wind speed never exceeded 60 percent at even the farthest distance recorded.

Compared to wind speed, the change in temperature in the protected area was insignificant. Figure 5 compares

the relative temperatures in the protected area during normal weather conditions. Under normal weather conditions, temperatures at two distances (2H and 16H) from the windbreak were similar in the protected area. This suggests that the daytime temperature was slightly warmer throughout the protected area than in the open area (the flat line represents control temperature). However, reduction of wind speed and the upward transfer of heat from the surface increased the nighttime temperature by a few degrees.

Cold fronts during winter months are associated with severe weather conditions. Temperatures can drop by several degrees (often below freezing) within an hour. Cold fronts also bring strong wind gusts. Figure 6 compares the relative temperatures in the protected area during cold fronts.

During cold fronts, the diurnal temperature behind the windbreak appeared to be slightly higher compared to normal days. Nighttime temperature was found to be a few

degrees higher on calm nights. The temperature on windy nights appears to be lower near the windbreak.

Effectiveness of windbreaks

The effectiveness of windbreaks depends on several major variables: wind direction and windbreak porosity, height, and length. Windbreak effectiveness gradually decreases as wind changes from a perpendicular to a parallel direction (Figure 3) to the windbreak. Windbreaks should thus be planted perpendicular to the prevailing wind.

Dense windbreaks are more effective than porous windbreaks. For this reason, it is often desirable to plant evergreen species with longer crowns for year-round protection. Windbreak height and length determine the area protected by the windbreak. As a low pressure zone develops behind the windbreak, air is pulled in from the ends. Windbreaks should thus be longer than the actual area requiring protection.

It is often difficult to obtain all these variables in a single row of windbreak growers. Hence, it is better to consider the use of multiple species, such as cadaghi and redcedar, in paired rows. In this case, the shorter species (redcedar) should be the outer row while the taller species make up the inner row. This improves windbreak effectiveness; however, additional space and resources will be required. ■ *Bijay Tamang and Donald L. Rockwood work at SFRC, University of Florida, PO Box 110410, Gainesville, FL 32611. Michael G. Andreu works at the SFRC, University of Florida, Gulf Coast REC - Plant City, 1200 N. Park Road, Plant City, FL 33563.*

References: 1) Gottwald, T. R. and L. W. Timmer. 1995. The efficacy of windbreaks in reducing the spread of citrus canker caused by Xanthomonas campestris pv. citri. Tropical Agriculture (Trinidad) 72(3):194-201; 2) Gottwald, T. R., J. H. Graham and D. S. Egel. 1992. Analysis of foci of infection of Asiatic citrus canker in a Florida citrus orchard. Plant Diseases 76:386-396; 3) Graham, J. H. and T. R. Gottwald. 1992. Research perspectives on eradication of citrus bacterial diseases in Florida. Plant Diseases 75:1193-1200; 4) Leite, R. P., Jr. and S. K. Mohan. 1990. Integrated management of citrus bacterial canker caused by Xanthomonas campestris pv. citri in the State of Parana, Brazil. Crop Protection 9:3-7; 5) Nuberg, I. K. 1998. Effect of shelter on temperate crops: a review to define research for Australian conditions. Agroforestry Systems 41:3-34; 6) Sudmeyer, R.A. and P. R. Scott. 2002. Characterization of a windbreak system on the south coast of Western Australia. 1. Microclimate and wind erosion. Australian Journal of Experimental Agriculture 42:703-715.

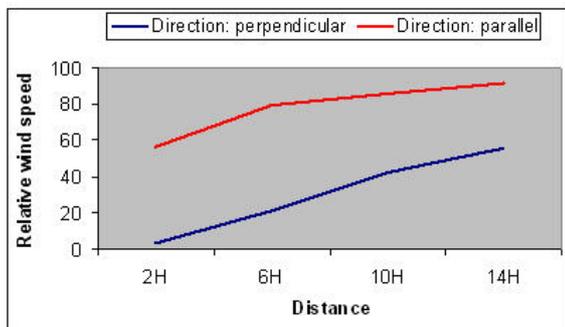


Fig. 3. Comparison of relative wind speeds at various distances from the windbreak at SWFREC, Immokalee, Florida on 21 January 2008.

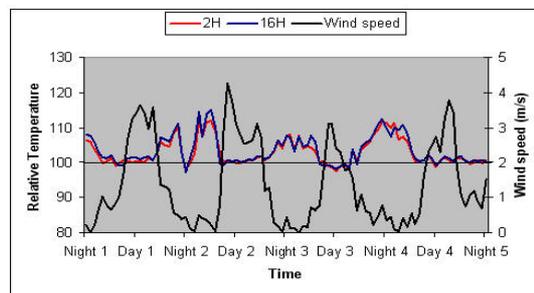


Fig. 5. Relative temperature at the distance of two times the height of the windbreak (2H, red line) and 16H (blue line) and the associated wind speed.

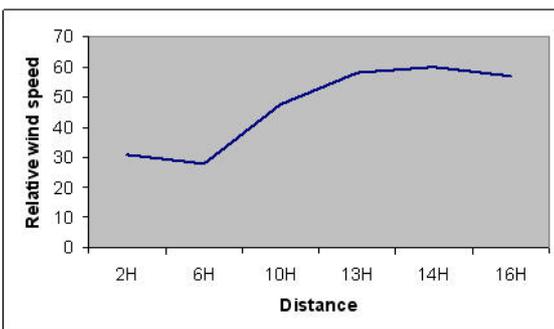


Fig. 4. Relative wind speed at various distances from the windbreak at C&B Farms near Clewiston at 6 pm on 3 January 2008 when wind direction was nearly perpendicular to the windbreak.

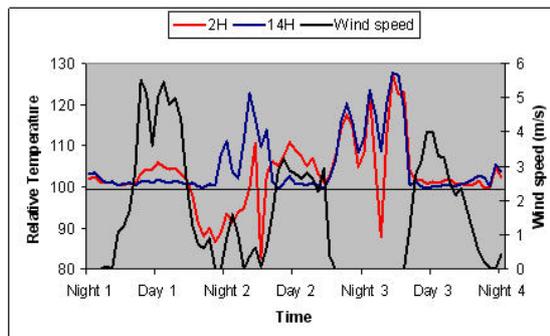


Fig. 6. Relative temperature at the distance of two times the height of the windbreak (2H, red line) and 14H (blue line) and the associated wind speed (black line) at SWFREC, Immokalee, Florida on 27-29 January 2008 during cold fronts.

Gaining profits from agroforestry in the rainfed, semi-arid, sub-tropics of central India

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Researches attest to the capability of agroforestry systems to improve the yields of both the tree and the understorey crop components. However, very little data is available on agroforestry systems that are productive in rainfed, semi-arid and sub-tropical areas. Most often, conditions in these areas are not conducive to agriculture.

In semi-arid and sub-tropical areas, the average rainfall is 900 mm and evaporation is at 1 800 mm. Growing crops under rainfed conditions is limited only to one season (rainy or winter) and depends on soil type. Venturing into agriculture is very risky due to the low and erratic rainfall, poor soil fertility and low water-holding capacity of the soil. Such areas also experience drought and floods at least once every three to four years.

From 1998 to 2005, an applied research project was conducted at the central farm of the Indian Grassland and Fodder Research Institute, Jhansi, in central India. The

research site is considered a semi-arid, sub tropical area. The research aimed to study the productivity of the tree species, with and without crops in the interspaces, under rainfed, semi-arid conditions.

Various combinations of trees and understorey crops were established. The four tree species used were *Albizia lebbek*, *Azadirachta indica*, *Dalbergia sissoo* and *Acacia nilotica*. Barley and chickpea (*Cicer arietinum*) were established as understorey crops.

A total of 14 treatments were established in a replicated randomized block design.

The treatments were as follows:

1. *Albizia lebbek* without any intercrop;
2. *Albizia lebbek* with barley as the intercrop;
3. *Albizia lebbek* with chickpea as the intercrop;
4. *Azadirachta indica* without any intercrop;

5. *Azadirachta indica* with barley as the intercrop;
6. *Azadirachta indica* with chickpea as the intercrop;
7. *Dalbergia sissoo* without any intercrop;
8. *Dalbergia sissoo* with barley as the intercrop;
9. *Dalbergia sissoo* with chickpea as the intercrop;
10. *Acacia nilotica* without any intercrop;
11. *Acacia nilotica* with barley as the intercrop;
12. *Acacia nilotica* with chickpea as the intercrop;
13. Barley only (without trees); and
14. Chickpea only (without trees).

The tree saplings were planted during the monsoon season of 1998 using 6-m x 12-m spacing. The understorey crops were introduced during the winter seasons of 1999 to 2000. During the rainy seasons of 2004 and 2005, fodder cowpea was introduced as an understorey crop following barley and chickpea. Fodder cowpea was used as a common treatment in all the plots, including the sole planting of trees.

After 2000, the trees were pruned to 50 percent of their height to provide sufficient light to the understorey crops. Pruning was done every June and October. The prunings were used as forage and fuelwood. They were also recorded as products from the tree component of the agroforestry system.

The cost and net returns for each treatment were estimated each year from 1999 to 2004 (Table 1). The total costs and net returns during the same duration were also estimated (Table 2).

Table 1 shows that planting solely trees was the least costly. As expected, the data showed low net benefit returns (NBR). In the first two years (1999-2000 and 2000-2001), the net benefit returns were higher in the treatments of *Dalbergia* with chickpea in the interspaces. In subsequent years, higher net benefit returns were recorded from the sole planting of



Fig. 1. The net returns of *Dalbergia sissoo* with chickpea as intercrop are measured during a five-year period.

chickpea. In the tree-crop combination, the *Dalbergia* with chickpea treatment maintained high net benefit returns from 1998 to 2005, except in 2002 to 2003 when the *Albizia* and chickpea treatment obtained the highest net benefit returns.

Meanwhile, Table 2 shows that the sole planting of chickpea recorded the maximum cost (Rs 55 952 or US\$1 166) and net benefit returns (Rs 62 622 or US\$1 305). Profit was obtained at only Rs 6 670 (US\$139).

Dalbergia with chickpea as an understorey crop obtained the highest profit at Rs 13 183 (US\$275) during the five-year period.

The estimated data (Table 2) clearly indicates that treatments with chickpea (*Cicer arietinum*) obtain profits. Hence, growing *Dalbergia sissoo* as the tree component and cultivating chickpea in the interspaces is a profitable venture in rainfed, semi-arid and sub-tropical areas. These results are supported by the findings of Korwar et al. (2006) for the work

done under rainfed and semi-arid conditions where economic analyses found agroforestry systems superior to monocrop systems. ■ Dr. Gill is Ex. Principal Scientist while Dr. Singh is Ex. Senior Scientist at the Indian Grassland and Fodder Research Institute, Jhansi (UP)-284003, India.

Reference: Korwar, G.R., G.Pratibha, V.Ravi and D. Palani Kumar (2006). Performance of castor (*Ricinus communis*) and green gram (*Vigna radiata*) in agro forestry system in semi arid tropics. *Indian J. Agronomy* 51(2): 112-115.

Table 1. Costs and net returns (NR) of the different treatments.

Treatments	1999-2000				2000-2001				2001-2002				2002-2003				
	Cost*	US\$	NR*	US\$	Cost*												
1. <i>Albizia lebbek</i> without any intercrop	3297	69	424	9	2712	57	1201	25	2545	53	953	20	2383	50	746	16	1500
2. <i>Albizia lebbek</i> with barley as intercrop	8475	177	4739	99	7114	148	5726	119	8100	169	5316	111	6339	132	4927	103	5441
3. <i>Albizia lebbek</i> with chickpea as intercrop	10240	213	11591	241	10732	224	11747	245	8858	185	10146	211	7261	151	8752	182	6314
4. <i>Azadirachta indica</i> without any intercrop	3366	70	579	12	2712	57	1108	23	2543	53	948	20	2378	50	809	17	1500
5. <i>Azadirachta indica</i> with barley as intercrop	8518	177	6266	131	7445	155	7125	148	6325	132	5229	109	5358	112	3655	76	5465
6. <i>Azadirachta indica</i> with chickpea as intercrop	10308	215	12606	263	10823	225	10677	222	8357	174	9653	201	6292	131	8725	182	6287
7. <i>Dalbergia sissoo</i> without any intercrop	3671	76	2290	48	3344	70	2852	59	2852	59	1944	41	2458	51	1196	25	1616
8. <i>Dalbergia sissoo</i> with barley as intercrop	6046	126	7165	149	7976	166	6307	131	6553	137	4640	97	5341	111	3256	68	4496
9. <i>Dalbergia sissoo</i> with chickpea as intercrop	13324	278	15353	320	11435	238	16288	339	8627	180	11996	250	6286	131	8433	176	6343
10. <i>Acacia nilotica</i> without any intercrop	3539	74	2364	49	3691	77	2961	62	2958	62	1512	32	2340	49	339	7	1443
11. <i>Acacia nilotica</i> with barley as intercrop	9532	199	8739	182	8135	169	5259	110	6603	138	4713	98	5305	111	2316	48	5517
12. <i>Acacia nilotica</i> with chickpea as the intercrop	11563	241	14342	299	11379	237	11936	249	8593	179	9519	198	6259	130	7481	156	6275
13. Barley only (without trees)	9444	197	2729	57	8583	179	2296	48	8584	179	2296	48	8813	184	13137	274	7584
14. Chickpea only (without trees)	10837	226	5985	125	12838	267	15196	317	12839	267	15196	317	9834	205	10279	214	9604

*1US\$ = Rs 48.00

Table 2. Costs and net benefit returns (NBR) of the different treatments.

Treatments	Total Cost (1999-2004)*	US\$	Total Net Returns (1999-2004)*	US\$	+ (gain)/ (loss)*	US\$
1. <i>Albizia lebbek</i> without any intercrop	12437	259	4319	90	-8118	-169
2. <i>Albizia lebbek</i> with barley as intercrop	35469	739	24402	508	-11067	-231
3. <i>Albizia lebbek</i> with chickpea as intercrop	43405	904	48934	1019	5529	115
4. <i>Azadirachta indica</i> without any intercrop	12499	260	4366	91	-8133	-169
5. <i>Azadirachta indica</i> with barley as intercrop	33111	690	26300	548	-6811	-142
6. <i>Azadirachta indica</i> with chickpea as intercrop	42067	876	48673	1014	6606	138
7. <i>Dalbergia sissoo</i> without any intercrop	13941	290	10267	214	-3674	-77
8. <i>Dalbergia sissoo</i> with barley as intercrop	30412	634	26844	559	-3568	-74
9. <i>Dalbergia sissoo</i> with chickpea as intercrop	46015	959	59198	1233	13183	275
10. <i>Acacia nilotica</i> without any intercrop	13891	289	7597	158	-6374	-133
11. <i>Acacia nilotica</i> with barley as intercrop	35092	731	25383	529	-9709	-202
12. <i>Acacia nilotica</i> with chickpea as the intercrop	44069	918	49054	1022	4895	102
13. Barley only (without trees)	43008	896	27099	565	-15909	-331
14. Chickpea only (without trees)	55952	1166	62622	1305	6670	139

*1US\$ = Rs 48.00

Exploring opportunities for integrating multipurpose trees on farms in Cambodia

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Agriculture is vitally important for the Cambodian economy. It employs around 77 percent of the country's labor force. The majority of farming operations are small family farms, with the average farm ranging from one to two hectares (McKenney and Prom 2002). The farming systems on the central plains of Cambodia are based primarily on rice production, with secondary crops of fruit trees, cashews and vegetables grown in home gardens.

Rice is the most important agricultural crop in Cambodia. Much effort has gone into improving rice production in the country following years of war (Nesbitt 2003). These efforts have been generally successful as Cambodia now experiences a small rice surplus. Despite this, many Cambodian families still face problems on food insecurity and malnutrition.

It is becoming increasingly clear that Cambodian agriculture needs to be diversified and farm productivity increased to create more employment opportunities. At the same time, there is a need to ensure a diverse and

nutritious food supply. Agroforestry systems that integrate trees on farms for improved production and provision of environmental benefits are viable options for farming families.

Building on traditional agroforestry practices

There are a number of traditional agroforestry practices that exist in Cambodia, with many farmers already growing a range of trees on their farms. However, these trees are often neither integrated with the other farm components nor are they being effectively managed. Moreover, some of the important agroforestry tree species, such as *Leucaena leucocephala*, *Flemingia macrophylla* and *Gliricidia sepium*, are not widely grown by Cambodian farmers.

Research was conducted among 30 farmers from two communes in Prey Veng Province to determine the opportunities of integrating multipurpose trees into Cambodian farming systems. Multipurpose trees include shrubs, palms and others that offer multiple products and services

when grown as part of an integrated farming system.

Initial findings showed the interest of farmers in growing multipurpose trees on their farms once they understood the full range of benefits that these trees could provide (Nuberg and Simmons 2004).

Table 1 lists the important tree species that may be integrated in agroforestry farms. Although not exhaustive, the list serves to illustrate some of the hundreds of species that could be grown more widely on Cambodian farms.

Integrating multipurpose trees in rice fields

Small banks separate individual rice fields on the central plains of Cambodia. Forest trees (mostly *Dipterocarpus spp.*), old fruit trees (mostly *Mangifera indica*), and palms (*Borassus flabellifer* and *Cocos nucifera*) still grow on some of these banks. Many more of these palms and other multipurpose trees (*Acacia auriculiformis*, *Ceiba pentandra*, *Feronia limonia*, *Peltophorum pterocarpum*, *Sadaricum koetjape* and *Tamarindus indica*) could be planted on these banks and even along the boundaries of rice fields to provide varied products such as fruits, fiber, timber, fuelwood and palm sugar. They may even provide additional services such as shade, shelter and erosion control.



Cambodian farmers collect *Leucaena leucocephala* seeds and plant them in their rice fields and home gardens, or integrate them with livestock raising.



Borassus flabellifer is integrated in rice fields as source of fruits, palm sugar, palm wine, fiber, fuelwood and timber.

In addition, these multipurpose trees can rehabilitate the poor soils and even encourage farmers to refrain from using expensive fertilizers. Shelterbelts and hedgerows of nitrogen-fixing trees (*Flemingia macrophylla*, *Gliricidia sepium* and *Leucaena leucocephala*) could be planted on these banks to enrich soil nutrients. Some species, such as *Crotalaria juncea* and *Sesbania rostrata*, can be grown directly on the rice fields and ploughed into the soil as green manure.

Adding multipurpose trees in home gardens

Home gardens in Cambodia vary in terms of appearance and utility. They range from relatively simple systems, with a few species planted, to complex multistoried systems, with many species planted. Sizes range from 0.1 ha to 1 ha (Simmons 2003). Most gardens have at least a few fruit trees and palms, while others have a complex mix of palms, fruit trees, perennial and annual food crops, herbs and spices.

The most commonly grown trees and palms in home gardens are coconut (*Cocos nucifera*), betel palm (*Areca catechu*), mango (*Magnifera indica*), papaya (*Carica papaya*), cashew (*Anacardium occidentale*), guava (*Psidium guajava*) and jackfruit (*Artocarpus heterophyllus*).

Most Cambodian home gardens can integrate many fruit trees and palms, arranged in a multilayered garden system, to make maximum use of space. Nitrogen-fixing trees (*Gliricidia sepium*, *Leucaena leucocephala* and *Sesbania grandiflorus*) could also be incorporated into home gardens as live fences or interplanted with other species. They provide nitrogen and mulch for soil improvement and support of vines. Live fences could be an alternative to the construction of fences around home gardens and houses. Building these live fences every few years, however, requires much labor and timber resources.

Table 1. Some important multipurpose trees for integration in Cambodian farming systems

Scientific name	English common name	Khmer common name	Products	Services
<i>Acacia auriculiformis</i>	Australian wattle	<i>plai cherng</i>	* timber * fuelwood * charcoal * paper pulp * tannin	* controls erosion * provides construction materials for shade and shelter * acts as nitrogen-fixing crop * improves the soil
<i>Albiza saman</i>	raintree	<i>ampel barang</i>	* edible pods * fodder from pods * fuelwood * timber	* provides construction materials for shade and shelter * acts as nitrogen-fixing crop * improves the soil * serves as ornamental crop
<i>Borassus flabellifer</i>	sugar palm	<i>tenout</i>	* fruit * palm sugar * palm wine * fiber * fuelwood * timber	* can be used as intercrop * serves as ornamental crop
<i>Cajanus cajan</i>	pigeon pea	<i>sondaik ankrea</i>	* edible seeds and pods * fodder from leaves * pods and seeds * fuelwood	* controls erosion * provides construction materials for shade and shelter * acts as nitrogen-fixing tree * improves the soil
<i>Ceiba pentandra</i>	kapok, cotton tree	<i>kow</i>	* fiber for pillows * oil seed * fodder from seed cake * timber	* serves as live fence * may be planted as field boundaries
<i>Crotalaria juncea</i>	sun hemp	<i>kak tung</i>	* fiber for twine * fiber for canvas * fiber for paper	* acts as nitrogen-fixing tree * improves the soil * serves as cover crop
<i>Dipterocarpus alatus</i>	hairy-leafed apitong	<i>chhour teal tuk</i>	* timber * resin	* improves the soil * can be used as intercrop
<i>Feronia limonia</i>	wood apple	<i>khut</i>	* fruit * fodder * fuelwood * timber * resin	* serves as live fence * may be planted as field boundaries * serves as ornamental crop
<i>Flemingia macrophylla</i>	large-leaf flemingia	(unknown)	* fodder * fuelwood	* controls erosion * provides construction materials for shade and shelter * serves as live fence * acts as nitrogen-fixing crop * improves the soil
<i>Gliricidia sepium</i>	gliricidia	(unknown)	* edible flowers * fodder for ruminants * fuelwood	* controls erosion * provides construction materials for shade and shelter * serves as live fence * acts as nitrogen-fixing crop * improves the soil
<i>Jatropha curcas</i>	physic nut	<i>lahong khwong</i>	* oil seed for bio-diesel * dye	* controls erosion * serves as live fence
<i>Leucaena leucocephala</i>	leucaena	<i>kanthum theet</i>	* fodder * fuelwood * paper pulp	* controls erosion * provides construction materials for shade and shelter * serves as live fence * acts as nitrogen-fixing crop

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The use of multipurpose trees as live fences not only reduces the labor input for building fences but also conserves forest resources. They provide additional products such as mulch, fodder, fuelwood, timber, stuffing fiber (*Ceiba pentandra*), oil seed for bio-diesel production (*Jatropha curacus*). They provide services such as shade, shelter and barriers to livestock. The live fences can also be used as windbreaks, particularly if *Acacia auriculiformis*, *Albizia saman*, *Pithecellobium dulce* and *Tamarindus indica* are planted along roadways. These trees control dust and provide shade, particularly during the dry season.

Combining the planting of multipurpose trees with livestock raising

Aside from cultivating crops, Cambodian farmers also raise a variety of animals not only for food but also for on-farm power and added income. Fodder trees and shrubs (*Cajanus Cajun*, *Flemingia macrophylla*, *Leucaena leucocephala*, *Morus alba* and *Sesbania grandiflorus*) may thus be grown as live fences around home gardens, animal pens and rice fields. They provide protein-rich fodder for livestock, particularly during the dry season when feed is scarce. Many of these species also fix nitrogen and provide fuelwood or timber for small construction works.

Identifying gaps and future actions

The integration of multipurpose trees on Cambodian farms is a viable option for improving agricultural productivity and ensuring a diverse and nutritious food supply for a growing population.

The range of tree species found in Cambodia is very similar to those found in Vietnam and Thailand. However, the agricultural extension services in Cambodia have only been established relatively recently. There is still very little research and minimal extension efforts on agroforestry being conducted in the country. As such, there is still a lack of models for agroforestry systems that are based on local research and development.

Agricultural organizations should implement initiatives to introduce farmers to the benefits of integrating multipurpose trees on their farms. Collaboration with other agencies to develop demonstration sites of systems and practices that realize the benefits of integrating these trees on farms is encouraged.

On the positive side, there has been some planting of *Acacia auriculiformis* along roadsides to protect against erosion and flooding. There have also been some fuelwood and timber plantations developed over the last 10 to 15 years. These initiatives provide valuable seed sources and show farmers that planting trees is easy to do.

The development of smallholder fuelwood systems is an area that needs more attention. In most rural areas, and even in many of the cities, the demand for fuelwood and charcoal for cooking is high. Given the extensive deforestation in Cambodia during the 1990s, there are various potentials and opportunities in developing tree plantations to produce charcoal. Community forestry schemes have been popular with donors and NGOs. Some farmers, however, are hesitant to work together with the other participants on these schemes.

Table 1. (Continued...)

Scientific name	English common name	Khmer common name	Products	Services
<i>Morus alba</i>	white mulberry	<i>darm moan</i>	* fruit * fodder * fuelwood * timber * tannin	* provides construction materials for shade and shelter * improves the soil
<i>Peltophorum pterocarpum</i>	golden flame	<i>trasake</i>	* fodder * fuelwood * timber * dye	* provides construction materials for shade and shelter * acts as nitrogen-fixing crop * improves the soil * serves as ornamental crop
<i>Pithecellobium dulce</i>	Manila tamarind	<i>ampel tuk</i>	* fruit * fodder	* provides construction materials for shade and shelter * acts as nitrogen-fixing crop * serves as live fence * serves as ornamental crop
<i>Sadaricum koetjape</i>	santol	<i>komping riech</i>	* fruit * timber	* controls erosion * serves as ornamental crop
<i>Sesbania grandiflora</i>	sesbania	<i>ankir dai</i>	* edible leaves, seeds, pods and flowers * fodder	* provides construction materials for shade and shelter * acts as nitrogen-fixing crop * improves the soil * serves as live fence * serves as ornamental crop
<i>Sesbania rostrata</i>	rostrata	<i>senow</i>	* edible leaf meal * fodder * light fuel	* acts as nitrogen-fixing crop * improves the soil
<i>Tamarindus indica</i>	tamarind	<i>ampel chew</i>	* fruit * edible young leaves * fodder * fuelwood * timber * tannin * dye	* provides construction materials for shade and shelter * may be planted on field boundaries * serves as ornamental crop

In some areas, it may be more appropriate to develop fuelwood plantations that are privately run by farmers.

Cambodian organizations that are interested in undertaking initiatives on agroforestry development could examine agroforestry models that have been developed by neighboring countries and adapt these models to local conditions. The Cambodian Agricultural Research and Development Institute (CARDI) started some experimentation with an integrated livestock-rice-fishpond system. This system is similar to the VAC system from neighboring Vietnam. This type of research and development on the integration of farming systems applicable to smallholders needs to be given a higher priority. ■ Luke Simmons is a consultant on sustainable agriculture and natural resource management in Southeast Asia. Dr Ian Nuberg is a senior lecturer in agroforestry at the School of Agriculture, Food and Wine, University of Adelaide.

References: 1) Agroforestry Database, World Agroforestry Centre, Nairobi, Kenya. URL: <http://www.worldagroforestry.org/Sites/TreeDBS/aft.asp>; 2) McKenney, B. and Prom. T. 2002. Natural resources and rural livelihoods in Cambodia: a baseline assessment. Cambodian Development Resource Institute, Phnom Penh, Working Paper No. 23, 116 pages; 3) Nesbitt, H. 2003. Developing sustainable rice production systems in Cambodia: An Australian contribution. In "Solutions for a better environment". Proceedings of the 11th Australian Agronomy Conference, 2-6 February 2003, Geelong, Victoria. Australian Society of Agronomy; 4) Nuberg I.K and Simmons, L. 2004. Agroforestry systems development in Eastern Cambodia. In "Working Together for Sustainable Landuse Systems". Book of Abstracts for the 1st World Congress of Agroforestry, 27 June – 2 July 2004, Orlando, Florida; 5) Simmons, L. 2003. Agroforestry practice in Cheach and Krabou communes in southeastern Cambodia, Honours thesis, University of Adelaide.

Encouraging student competencies in agroforestry entrepreneurship

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Recognizing the role of entrepreneurship in the promotion of agroforestry education in Mindanao, Philippines, the Misamis Oriental State College of Agriculture and Technology (MOSCAT), through its Institute of Agriculture-Agroforestry Department, applied for funding support from the Department of Science and Technology (DOST). Application was channeled through DOST's Technology Application and Promotion Institute (TAPI)-Science and Technology Enterprise Assistance Mechanism (STEAM).

In April 2003, TAPI agreed to fund five agricultural production projects amounting to Php 417 000 (\$10 171). The projects were under the DOST-Academe Technology-Based Enterprise Development (DATBED) program and the Small Enterprise Technology Upgrading Program (SETUP).

The DATBED and SETUP programs

The DATBED program aims to build the entrepreneurial skills of students, young professionals and even out-of-school youth by helping them establish income-generating projects for their schools or organizations (Office of the President 2007).

Meanwhile, SETUP aims to promote the technology application/upgrading of small- and medium-sized enterprises (SMEs). SETUP is envisioned to enhance the development of five industries, namely: food processing; furniture making; production of fashion accessories; production of gifts, toys and houseware; development of livelihood projects from marine and aquatic resources; and horticulture initiatives (DOST 2003).

According to Dr. Estrella Alabastro, DOST Secretary, "After graduation, the students who were involved [in these programs] would no longer have the need to seek employment because they already have [their own] businesses to run."

The BAFT degree

For MOSCAT, the SETUP and DATBED programs aim to provide credit assistance to students graduating with the Bachelor in Agroforestry Technology (BAFT) degree, and train them to engage in entrepreneurial activities.

The BAFT program aims to develop professionals with general competencies in carrying out the science, art and business of a dynamic and interactive process of production, management and utilization of agroforestry components. The agroforestry components are established either zonally, mixed-simultaneously or sequentially on a piece of land to conserve resources and maintain socio-economic productivity.

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Established in 2006 by one of the student-recipients of the SETUP-DATBED programs, this 2-ha corn plantation is now on its third cropping season and has earned an income of Php32 400 (almost US\$700).

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Specifically, the program aimed to: 1) develop agroforestry graduates who have the knowledge and skills in forestry and agricultural operations, management, and research in the public and private sector; 2) train competent agroforestry professionals who can understand the dynamics and interactive processes that exist in the production, management and utilization of the agroforestry components; 3) train students to become self-reliant and self-sufficient agroforestry entrepreneurs; and 4) provide the students with adequate professional training to develop work habits, appreciate the dignity of labor, and become honest, constructive and critical thinkers, aside from being proficient and competent agroforesters.



A group of students tying tomato plants in one of the farms established through the SETUP-DATBED programs. This group received Php 53 740 (US\$1 115) loan from the program.



A group of students standing beside their fattened cattle at MOSCAT's Agroforestry Field Laboratory. Cattle fattening is one of the enterprises supported by the SETUP-DATBED program.

The case of MOSCAT

With the approved funding support, MOSCAT implemented different agricultural enterprises from April 2003 to March 2005 through the efforts of the BAFT students. These were the production of corn, sweet potato, tomato and peanut, and the raising of Kabir chicken. Two new projects were added in 2006, namely: cattle feedlot fattening and carrot production.

From the funds provided, 7.5 percent were released as loans to students for corn production, 3.8 percent were loaned for sweet potato production, 45.5 percent were loaned for tomato production, 5.6 percent were loaned for peanut production, and 37.6 percent were loaned for the raising of Kabir chicken. Cattle feedlot fattening and carrot production were also allotted funds from the project.

There were 65 BAFT students who benefitted from the SETUP and DATBED funding support from April 2003 to December 2006. Forty-four (65%) of them had already graduated.

Graduate students who are beneficiaries of the program were encouraged to apply for loans under Stage II. The College nominates the graduate students to DOST Region 10 based on the merit of his/her feasibility study and relevant documents. Stage II offers zero percent interest with unlimited amount of financial support based on his/her feasibility study.

Impacts of the programs to BAFT

The implementation of the SETUP and DATBED programs helped upgrade MOSCAT's BAFT curriculum. One subject (Practicums 5 and 7) was split into two units of summer class and two units of class in the first semester. This enabled the student-beneficiaries to prepare the land during summer for the seasonal planting of agricultural crops.

The two programs also strengthened MOSCAT's accreditation to the Agency of Chartered Colleges and Universities in the Philippines, Inc. (AACCUP). Three areas were enhanced by the two programs, namely: curriculum and instruction, student support, and extension and community involvement. The BAFT program thus gained the highest percentage rating among other seven degree programs offered by MOSCAT that were submitted for accreditation last July 2005.

Impacts of the programs to the students

For the students, the DATBED and SETUP programs reduced their difficulties in finding funds to finance their micro-projects. At the same time, they were able to develop a high sense of responsibility and ownership for the project. This was demonstrated in their resourcefulness to find ways in solving everyday problems and challenges.

Through experiential learning, the students proved their capabilities as innovative farmer-entrepreneurs. They applied their technical skills in agricultural crop production and livestock raising on the farm, and learned how to handle large-scale agricultural crop production. They practiced their entrepreneurial skills in terms of transacting businesses with banks, applying for loans, managing cash flow, applying bookkeeping and accounting, and budgeting.

The students also acquired time management skills as they balanced their full academic loads with farm maintenance, and business transactions. More importantly, they learned to consult with experts, through their technical advisers, just as farmers consult with scientists and extension agents regarding problems on their farms.

Impacts of the programs to MOSCAT

DATBED and SETUP strengthened the linkages and extension programs of MOSCAT, especially with DOST. The funds helped finance micro-projects which generated income for the College.

Through the two programs, BAFT students were able to apply what they have learned, and showcase their entrepreneurial competencies.

More importantly, the two programs demonstrated the success of MOSCAT's BAFT curriculum and proved that entrepreneurship is a relevant skill needed to successfully

implement agroforestry farms and projects. ■*The author is on the faculty of Misamis Oriental State College of Agriculture and Technology, Claveria, Misamis Oriental, Philippines.*

References: 1) Department of Science and Technology (2003). The Small Enterprise Technology Upgrading Program (SETUP). URL: <http://setup.dost.gov.ph/intro.php>. (Retrieved 27 February 2008).; 2) Office of the President (2007). From job seekers to employers: DOST – ARMM promotes entrepreneurship among youths. URL: <http://www.op.gov.ph/news.asp?newsid=18581>. (Retrieved 27 February 2008); 3) Palma, R.A. (2008). MOSCAT Small Enterprise Technology Upgrading Program – DOST – Academe Technology – Based Enterprise Development Program Accomplishment Report as of December 2007. A Terminal Report submitted to the Technology Application and Promotion Institute.

Kasetsart University hosts FORTROP II

Kasetsart University is hosting FORTROP II (17-20 November 2008), an international conference commemorating the 72nd anniversary of forestry education in Thailand. FORTROP II will be held at the Convention Center, KU Golden Jubilee Building, Kasetsart University, Bangkok, Thailand.

FORTROP II will focus on the different ways for researchers, technical professionals, and other stakeholders to actively share technologies and experiences so that tropical forest resources are used in a sustainable manner, and discuss the changes that affect the future of tropical forests.

Ten technical sessions will be held to address the theme "Tropical forestry change in a changing world." These are:

1. Tropical forests and climate change;
2. GIS/GPS/RS: applications in natural resources and environmental management;
3. International long-term ecological research;

4. Dry forest ecology and conservation;
5. Mangrove and wetland ecosystems;
6. Commercial plantation forestry;
7. Urban forestry and urban greening;
8. Trends and issues in community forestry;
9. Protected areas and sustainable tourism;
10. Forest products and bio-based material; and the
11. ASEAN Forestry Student Association (AFSA).

Technical visits will also be held to cover conservation centers, plantations, agricultural projects, national parks, mangrove forests, beach forests, orchards and various tourist attractions.

For more information, contact FORTROP II Secretariat, Faculty of Forestry, Kasetsart University, 50 Phaholyothin Road, Chatuchak, Bangkok 10900, Thailand, Tel (662) 579 0170, Fax (662) 561 4246, E-mail: FORTROP2008@ku.ac.th or visit <http://www.forest.ku.ac.th/fortrop2008>. ■

Journals for sharing agroforestry information and knowledge

With the increasing initiatives on agroforestry research, there is a need to look for ways to exchange information and knowledge among scientists, researchers, practitioners and even students.

The following peer-reviewed scientific journals are good avenues for information and knowledge sharing on original agroforestry research and other relevant initiatives:

Agroforestry systems

This is a peer-reviewed, international scientific journal that presents results of original research, critical reviews, short communications (initial research results), book reviews and other professional information on the biophysical and socioeconomic aspects of agroforestry. Scope of topics may cover fundamental or applied investigations, and research methodologies and techniques. It also includes articles that focus on analytical descriptions of rarely studied but promising agroforestry and other integrated systems that involve trees, crops and livestock. Editors encourage articles that provide new insights or significant contributions to the knowledge base, particularly those that are relevant to a broader context instead of those that are specific only to a particular location. For more information, visit <http://www.springer.com/life+sci/forestry/journal/10457>

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Journals for agroforestry...

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Environmental management

This journal presents the works of academic researchers and professionals outside universities, including those of business, government, research organizations and public interest groups. It offers research and opinions on the use and conservation of natural resources and the protection of habitats and control of hazards. Article contributions cover biology, botany, climatology, ecology, ecological economics, environmental engineering, fisheries, environmental law, forest sciences, geology, information science, public affairs, zoology, and other areas. For more information, visit <http://www.springer.com/life+sci/forestry/journal/10457>.

International forestry review (IFR)

IFR is a peer-reviewed scientific journal that publishes papers, comments and book reviews on international forest science, policy, management and conservation. It is published four times a year (March, June, September and December) with specific themes per issue. It has an impact factor of 0.924 as published in the Journal Citation Reports 2006 by Thomson Scientific. For more information, visit <http://www.cfa-international.org/IFR.html#info>.

New forests

This international journal publishes findings of original research on afforestation and reforestation. Articles focus on the reproduction of trees and forests that originate from seeds, seedlings or coppice for resource protection, timber production

and agroforestry. Topics cover silviculture, plant physiology, genetics, biotechnology, ecology, economics, protection, and the management of all stages of afforestation and reforestation. For more information, visit <http://www.springer.com/life+sci/forestry/journal/10457>.

Small-scale forestry

This journal presents ongoing research results and other efforts on the management of small-scale, non-industrial, private forest woodlots. This journal is published by the International Union of Forest Research Organizations (IUFRO) to promote information exchange on the economic and policy issues as well as the technical aspects of small-scale forestry. For more information, visit <http://www.springer.com/life+sci/forestry/journal/10457>. ■ *Compiled by Leah P. Arboleda*

New publications for the agroforesters

The following publications have been researched from the websites of Springer Publications, CABI International, and Earth Print:

Forestry and climate change

Edited by P. H. Freer-Smith, M. S. J. Broadmeadow and J. M. Lynch of Forest Research, UK, this book explores how forests interact with the physical and natural world, and that of humans as climate changes. Climate change is one of the greatest challenges being faced today because of its adverse impacts to societies and the scale of international cooperation needed to confront it. Central to this challenge is the role of forests. This book discusses how the world's forests can be managed to help mitigate climate change and maximize the economic and non-market benefits that they can provide. For more information, visit <http://www.cabi.org/>.

Indigenous fruit trees in the tropics: domestication, commercialization and utilization

This study presents the results of a comprehensive research on the biology, ecology and social impacts of indigenous fruit trees on rural populations, including new concepts and approaches that have evolved. The information presented highlights the need to domesticate various indigenous fruit trees to promote sustainable agriculture and improve the viability of rural livelihoods in developing countries. The indigenous fruit trees can be cultivated and owned by smallholder farmers. They can also be combined with cash crops in multifunctional and integrated farming systems. The cash crops provide food and immediate income, while the fruit trees also provide food and at the same time promote the economic growth of the farmer and his family.

This book has been edited by F. K. Akinnefesi, O.C. Ajayi and G. Sileshi of the World Agroforestry Centre, Malawi; R. B. Leakey of James Cook University, Australia; Z. Tchoundjeu of the World Agroforestry Centre, Cameroon; P. Matalaca of the World Agroforestry Centre, Mozambique; and F. R. Kwesiga of the Forum for Agricultural Research in Africa (FARA), Ghana. For more information, visit <http://www.cabi.org/>.

Lessons from forest decentralization

Written by Carol J. Pierce Colfer, Ganga Ram Dahal and Doris Capistrano, this book presents the research findings on decentralization in Asia-Pacific countries, and relevant lessons from other regions. It covers decentralization issues in forestry with clear lessons for policy, social equity, forest management, research, development and conservation in forested areas across the globe from the tropics to temperate regions.

This book highlights the rights, roles, responsibilities, organization, capacity-building, infrastructure and legal aspects of decentralization. It discusses many controversial issues and provides recommendations that address the challenges of financing or reinvesting on sustainable forest management under decentralized governance. For more information, visit: <http://www.earthprint.com/>.

Managing forest ecosystems: the challenge of climate change

Edited by F. Bravo, V. LeMay, R. Jandl and K.V. Gadov, this book discusses the latest scientific evidence on the relationships between climate, forest resources and forest management practices around the world. It presents an in-depth analysis of the biological and economic impacts of climate change, including forest responses to climate change, monitoring and modeling changes, economic and management implications, and carbon sequestration under specific management systems. For more information, visit <http://www.springer.com/>.

Sustainable farmland management: new transdisciplinary approaches

This book examines the relationship between sustainability and farmland management according to different temporal, spatial and production contexts. The main contents include sustainability and farmland management, information and knowledge for sustainable farmland management, ethical production and protection, multifunctionality and sustainable farmland management, systems for sustainable farmland management, and scales of sustainable farmland management. For more information, visit <http://www.cabi.org/>.

Compiled by
Leah P. Arboleda

Useful websites and links

The Earth Portal

<http://www.earthportal.org/>

The Earth Portal is a comprehensive resource for timely, objective, and free science-based information about the environment.

The website features Earth Portal's three components:

- Encyclopedia of the Earth;
- Earth Forum; and
- EarthNews.



FAO World Agricultural Information Centre (WAICENT)

http://www.fao.org/waicent/promotion/promotion_en.asp

The Food and Agriculture Organization of the United Nations established WAICENT for effective agricultural information management

and dissemination. It provides access to the accumulated knowledge and expertise of FAO. It improves the capacities of decision-makers, professionals and the public to obtain and use information that are essential in achieving sustainable agriculture development and helping to combat hunger.



FAO WAICENT Fighting Hunger with Information



The Food and Agriculture Organization of the United Nations and its 183 Members highlight information as one of the priority areas in fighting hunger and achieving food security. As a result, FAO established the World Agricultural Information Centre (WAICENT) for agricultural information management and dissemination, in an effort to fight hunger with information. WAICENT is FAO's strategic framework for improving access to essential documents, statistics, maps and multimedia resources to millions of users around the globe.

Today, FAO WAICENT is one of the world's most comprehensive sources of agricultural information, providing access to the accumulated knowledge and expertise of FAO, improving the capacities of decision-makers, professionals and the public-at-large to obtain and use information essential for achieving sustainable agriculture development and helping to combat hunger.

GLOSSARY OF DATABASES - A FOCUS ON WATER

FAO offers over hundreds of databases covering all areas of FAO expertise. There are many focusing on water issues, including [AquaStat](#), the [World River Sediment Yields Database](#), and [FAOSTAT](#). For a complete list, visit FAO's [Land and Water Development Division](#).

You can also access water related pages and databases through the FAO WAICENT [Subject Directory on Water](#).

You can also access articles and reports related to many aspects of water from [FAO's online catalogue](#), such as [Water & Food Security](#), [Water & Agricultural Development](#), and [Water resources](#).

Useful websites...

Trees for the Future

<http://www.treesff.org/about/sustain.htm>

Trees for the Future aims to help people in developing countries improve their rural livelihoods through the introduction of environmentally sustainable land management projects, with focus on beneficial tree planting. Beneficial trees minimize soil erosion, supply forage for animals and provide fuelwood. The website is considered an agroforestry resource center as it provides technical knowledge on agroforestry and sustainable development, along with information on planting materials.

Watch our new video and see how we have planted over 30 million trees!

Give a Tree Planting Certificate to a loved one!

\$100 Plants a forest! Plant a grove of trees and help us plant over 10 million trees in 2008

Exciting news: Nature's Grilling Products joins with TREES to plant 1 million trees in 2008!

Go to our projects page and learn more about our country programs

Sign up for our free monthly e-newsletter!

First Name: Last Name: Email:

We are a 501 (c) 3 Tax-Exempt Non-Profit Organization
EFC # 10715, Member of Aid for Africa
Member Aid For Africa

Trees for the Future | P.O. Box 7027 | Silver Spring, MD 20907 | 1.800.643.0001 or 1.301.505.0630 | [LINK PARTNERS](#)

Useful links

Agricultural Research for Developing Countries (CIRAD)*

<http://www.cirad.fr/en/index.php>

Australian Forests

<http://www.australianforests.org.au/index.htm>

Eldis*

<http://www.eldis.org/>

International Centre for Integrated Mountain Development (ICIMOD)

<http://www.icimod.org/home/>

Technical Centre for Agricultural and Rural Cooperation ACP-EU*

<http://www.cta.int/>

World Bank Agricultural Investment Sourcebook*

<http://www-esd.worldbank.org/ais/>

Wild Thyme Farm

<http://www.wildthymefarm.com/index.html>

Compiled by
Leah P. Arboleda

Call for contributions

We are inviting contributions for the 34th and 35th issues of the Asia-Pacific Agroforestry Newsletter (APANews) on or before 5 January and 18 May 2009, respectively.

Let us help you share the relevant programs and projects that you are doing in the areas of agroforestry research, promotion and development, and education and training.

Contributions for agroforestry research may contain results of short- and long-term studies on agroforestry.

Contributions for agroforestry promotion and development may contain information on various extension services aimed at promoting and developing agroforestry among communities.

Contributions for agroforestry education and training may contain

announcements on conferences, symposiums, training opportunities and other news on the various efforts being made toward generating more agroforestry professionals and practitioners, and providing venues for interpersonal sharing of agroforestry information, and networking opportunities.

We will also help you announce new information sources and useful websites.

For several years now, APANews has continued to reach out to people from various sectors. We are thus requesting interested contributors to adopt the simple, straightforward and popular style in writing the articles instead of that used in journals. By adopting the popular writing style, your articles can help farmers, development agents, researchers, practitioners and other interested individuals in coping with the challenges of promoting and

developing agroforestry in their respective countries, and at any level of project or research implementation.

FAO and IAF editors would like to accommodate as many articles as possible in every issue. Hence, kindly limit your contributions to 1 000 to 1 500 words, and include good-quality photographs (scanned at 300 dpi) that are properly labeled and referred to in the text. Please don't forget to include your complete contact details, especially your E-mail address, should the readers have questions, clarifications or requests for further information.

Kindly send contributions through E-mail as attachments or via snail mail in diskettes/CD-ROM or printed form to the FAO/RAP Office or 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, apanews0718@gmail.com, agro_cfnr@yahoo.com. ■