“Tree” of plenty — leucaena in the Philippines

Mahmoud Aziz

I pil ipil is the local name of Leucaena leucocephala in the Philippines. A tropical leguminous tree, leucaena originated in Central America and was spread by the Maya and Zapatec civilization throughout lowland Mexico. With the advent of the Spanish galleon trade to the Philippines from the West Coast of Mexico in 1581, leucaena crossed the Pacific and became a respected and widely naturalized animal browse legume in Southeast Asia. In the 19th Century it became a favored shade tree for plantations of coffee, cacao, quinine, and rubber. Leucaena was also used as a source of wood for charcoal; its leaves served as a vegetable, and its seed, as food or ornaments. Of all tropical legumes, leucaena probably offers the widest assortment of uses through its many varieties, producing nutritious forage, firewood, timber, and rich organic fertilizer. In addition to its products, growing leucaena has uses revegetating tropical hill slopes and providing windbreaks, firebreaks, and shade.

Of the leucaena genus, grouping 51 different species with more than 100 varieties, L. leucocephala is the one that is most exploited and referred to simply as leucaena. It can be classified into three main types:

- The Hawaiian type — short and bushy, grows to 5 meters in height — flowers when very young (4-6 months) and year round. Its yield of wood and foliage is low, and because of its continuous flowering producing many seeds, it spread widely in its native coastal Mexico. Its main value lies in its ability to revegetate tropical hill slopes.
- The Salvador type, a tall tree-like plant that grows to 20 meters, is known as the arboreal type. It often produces more than twice the biomass of the Hawaiian type.
- The Peru type are tall plants, up to 15 meters with extensive branching even low down on the trunk. It produces little trunk but extremely high quantities of foliage used as forage and also as fertilizer.

Large quantities of protein can be produced efficiently and economically from leucaena grown as forage on well drained fertile soils and harvested regularly. Leucaena forage is highly palatable, digestible, and nutritious for both beef and dairy cattle — with one qualification, discussed below. The plant's drought tolerance and hardiness make it a promising candidate for increasing meat and milk supplies in the dry tropics.

The feedmilling industry in the Philippines uses up to five percent of ipil ipil in livestock and poultry feeds. As the total annual output of the 10 leading feedmills is 600,000 metric tons of mixed feed, the potential requirement for leucaena reaches 30,000 metric tons annually. On the average only 2 percent of ipil ipil is added to feeds, however, mainly because it is not available in larger quantities.

I pil ipil meal contains 20-40 percent protein, and includes a balance of amino acids essential for good nutrition in livestock and poultry.

Used as fertilizer, leucaena helps to enrich soil and aids neighboring plants because its leaves are rich in nitrogen and other nutrients collected from the deep layers of soil by its long tap root system. Natural leaf drop returns nitrogen and other mineral nutrients to the soil through the action of microorganisms that quickly decay the young leaves, a process called “green manuring.”

The fertilizing value of leucaena is due both to its generous leaf litter and its nitrogen fixing activity. Nitrogen fixing in leucaena, like most legumes, is a result of the mutually beneficial partnership with Rhizobium bacteria in the soil. The bacteria penetrate the young leucaena rootlet, and multiply into colonies forming nodules on the root surface. The bacteria absorb large amounts of atmospheric nitrogen and convert it to other nitrogen compounds that the plant can use.

Leucaena also benefits the soil in which it grows by increasing the humus, breaking up compacted surface layers, improving water absorption, reducing moisture evaporation, reducing soil slippage and erosion, and providing a forest cover to protect the surface against the sun, rain, and wind.

Human action has deforested one-third of South America's native forests, one-half of Africa's, and two-thirds of Southeast Asia's (see Reports, Vol. 8 no. 3). If the trees are cut or burned, the roots die and the nutrients that then leach away to deeper soil layers are essentially lost. With nutrients and organic detritus gone, the soil surface cracks, dries in the heat and hardens like cement, or is eroded away by rain and wind.

There is an urgent need in the tropics to protect the remaining forest cover from further damage and to reforest already devastated areas. To replace the vegetation cover, deep-rooted, quick-growing, adaptable trees like leucaena are ideal.

The arboreal leucaena varieties grow rapidly, yielding wood of useful size for lumber and timber. Leucaena wood has the potential to become a major source of pulp and paper, roundwood, and construction material. Leucaena wood makes excellent firewood and charcoal, and has long been used as such in the Philippines. The wood has high density and high caloric or heating value (4.23 to 4.7 calories per gram). As the stumps rapidly regrow after cutting, it is a highly renewable fuel source.

In the Philippines some 15-20 percent of the total land area — about 5 million hectares — consists of grasslands and nonproductive forests. A national goal is to reforest and restore the productivity of this area, beginning with 1.4 million hectares in watershed areas.

The Philippines government has obtained a $US8.5 million loan from the World Bank to enable farmers to grow ipil ipil as leaf feed and for charcoal production. Supported by IDRC, the Philippines Council for Agriculture and Resources Research (PCARR) undertook a project in 1976 to develop the economic potential of leucaena for small landholders.
The most limiting factor in the use of leucaena is that its foliage contains an amino acid — mimosine — that is considered toxic and causes goitre and hair loss in most animals when the intake is too high (see box). Another limiting factor is that seedlings are slow-growing, leaving the tree vulnerable to adverse climatic conditions, weeds, and overgrazing. The tree crop is therefore difficult to establish. But once it is established, leucaena grows prolifically and can even become a nuisance if it is not properly managed.

The PCARR project has progressed, establishing leucaena stands in grass pastures as forage for beef production. It has been found that planting pregerminated leucaena seeds resulted in a larger population stand than the direct seeding of ungerminated seeds. During cultural management experiments, the plants were being cut at different heights every two months, and grown in different population densities. Data on herbage yield showed no significant difference as the density increased, but herbage yields increased as cutting height decreased from 100 cm to 30 cm and 15 cm. Fertilizer trials showed economy: plants fertilized with 50 kg of phosphorus per hectare yielded as much as those fertilized with 100 kg.

A small-scale or backyard forage production scheme for leucaena was established along fence lines, rice paddies, and areas under coconuts, as well as among legumes planted at different sites. Chemical and biological evaluation of ipil ipil herbage as feed were conducted to determine protozoal and total bacterial counts, to measure volatile fatty acids, and measure mimosine degradation in the rumen of the animals and its effects on health, weight gain, and reproductive performance.

As fertilizer, leucaena leaves — including the leaf stems and smallest twigs — were dried to constant weight, chopped, thoroughly mixed, and incorporated in the soil as an organic fertilizer on rice plantations. Grain yields ranged from 7 to 9 tons per hectare for areas fertilized with leucaena leaves, and 8.4 to 9.8 tons in areas fertilized with ammonium sulfate. Areas without fertilizer yielded 4.3 to 5.5 tons. A fertilizer regime using leucaena leaves on rice crops was developed, and another experiment is in progress to measure the effect of leucaena leaf fertilizer on corn yields.

These experiments will be followed by a study of the economics of leucaena production and its integration into appropriate farming systems using leucaena herbage both as organic fertilizer and as animal feed. This integrated scheme of crop and livestock production should particularly benefit small farmers whose livestock consists of only 2 or 3 head of cattle — typical of 85 percent of all cattle owners in the Philippines.

Leucaena’s prime importance to small farmers in the tropics is the economic resource it puts at their disposal. Farmers will be able to use the plant to increase production and ultimately, family income, utilizing only family labour as the major input — without increasing dependence on expensive technologies or products.

When initially fed on leucaena, cattle make excellent weight gains, but eventually suffer from mimosine toxicity — especially if leucaena is fed exclusively.

Cattle grazed on a leucaena-grass pasture gained rapidly — up to one kg a day — for as much as eight months before showing toxic effects. They would then begin to lose hair around the tail, sometimes completely losing the switch. In severe cases, cattle developed goitre (enlarged thyroid glands), appeared listless and unwilling to move, and salivated profusely. Growth tapered off, and some cattle began to lose weight. Not much is understood of the action of mimosine. There are clues, however. The mimosine appears to be converted by microorganisms in the first stomach of ruminants into a compound called DHP. This compound is absorbed into the bloodstream, is carried to the thyroid, and there interferes with the production of the thyroxine hormone by preventing the incorporation of iodine. Goitre, hair loss, and appetite depression are among the effects.

Researchers have tried a number of approaches to the problem. As the toxic effects can be reversed by changing livestock to a non-leucaena pasture, a “threshold” diet was developed. Provided stock do not exceed 30 percent leucaena in their diet, they seem to continue to thrive. Experiments have shown that in proper rations leucaena can boost milk production.

A more ambitious approach is trying to develop a leucaena plant with low levels of mimosine. The L. leucocephala varieties have all shown disappointingly uniform levels of mimosine, about 3–5 percent of the dry matter. Another species, L. pulverulenta, contains much lower levels, but is not vigorous enough to be suitable as a forage. There is also genetic incompatibility that hinders crossing the two species. Researchers at the Commonwealth Scientific and Industrial Research Organization (CSIRO) have had some success in breeding a variety with lowered mimosine.

Given all of leucaena’s other attributes, and its future potential as a multi-purpose crop, the mimosine problem will not likely be permitted to hold back this valuable legume.