APPENDIX A-MAGIC MOUNTAIN: 2000 AD

by James A. Duke[1]

Twas the year *2000* on Magic Mountain, in the Tropical Moist Forest Life Zone. None of the natives lived by the river anymore. After the last flood they abandoned the last alluvial homesite and moved up on top of Old Magic. This freed 100 of their most productive hectares for agriculture. Untended slopes yield 30 MT/ha biomass each year and the ridges where they now have their residences yield only 15. The bottomland they abandoned, fertilized by the floods that used to destroy their homes periodically, yields 150 MT/ha. With the help of leaf-protein extraction equipment, they are getting 3 MT protein per bottomland hectare, but the bulk of their bottomland biomass goes into barrels, as ethanol. Lo and behold, they are getting 2 barrels of alcohol for every MT of biomass, using firewood and residues to fuel the distillation, applying the ashes back to the farm. That's big money these days with ethanol at $100 a barrel, oil at $200. Instead of sending them arms, powdered milk, peanut butter, and fertilizer, the United States sent them LP (leaf protein) extractors, seeds (computer-selected for this ecosystem), inoculum, stills, and energy-producing portajohns.

Back in the 1990s some of the donors from the overdeveloped countries realized that they could nitrogenate more acres in the tropical backwoods with a kilo of inoculated legume seed than a kilo of nitrogen. Adventist Missionaries made their point back in 1990 when they showed the natives that they could get 10 to 20 times as much protein from leaves if they did the conversion themselves rather than let the cattle do it. So now, each hectare gives 3 tons of protein instead of 300 kg. As a byproduct they have 100 barrels of ethanol, worth $10,000. With their tropical climate, conducive to higher productivity, they are now exporting ethanol to the United States at $100 a barrel, while the Arabs are having trouble finding buyers for their oil at $200 a barrel, Instead of bananas at 5¢ a finger or coffee at one clam per kilo, the barge that chugs up the river hauls ethanol out for those profligate spenders up in the United States who are still sitting on their coal, to give them the energetic upper hand in case the Russians don't get out of Poland, Afghanistan, Syria, and Iran (all of whose oil had been burned up by saboteurs).

Neophytes to the Tropics thought that Magic Mountain was Virgin Rain Forest, but those of us in the know knew that nearly all of Magic Mountain was a multitiered, multiuse agroecosystem. The Virgin Rain Forest was the next ridge over, by Rocky Rapid River, i.e., Meyers Mountain. Rocky Rapid River still provides cold clear water and the electricity consumed on Magic Mountain. Meyers Mountain, now a State Park, has several endemic species that are being studied by the Natural Products people looking for better contraceptives and cancer cures, Neophytes thought this was Virgin Forest because it had more than 100 tree species per hectare in at least two tiers. Palms and legumes stuck out on top, with coffee and cacao in the lower tiers of some, leguminous vines in others, lemongrass in others, yams in others, and zingiberacous spices in the shade of others.

Finding forest on magic mountain surprised a lot of armchair botanists, who, back in the 1980s predicted that the forest would be reduced to savannoid "red desert, " But there were at least three strikes against the "red desert" hypothesis: 1) the Secretary of State convinced the President that trees alleviated rather than aggravated the pollution problem, so Americans were not running a "Down With Trees" campaign, 2) natives had experienced fewer bug and disease problems in their multitiered agroecosystems than in their brief monocultural experiments, and 3) Americans had encouraged a forest "barrier" between the hoof-and-mouth disease of Colombia and the Hamburger Farms in Central America. The Neophytes thought that the Americans had taught the Indians this multitiered approach, but, in fact, the Indians had taught the Americans. Even in temperate America, the Indians were intercropping when Columbus got here, with beans fixing a little nitrogen to supplement that left by the decaying fish they placed with their C-4 corn seed. The C-3 pumpkins we used for our Thanksgiving pie were used by the Indians as well. But they knew that the cucurbits smothered weeds long before young Dr. Duke discovered that cucurbits not only smothered the weeds, but allelochemically discouraged them.

The standard of living was almost as high on Magic Mountain as it was in New York City. A few hippies and naturalists thought it was even better. It seems that in spite of marvelous inventions in solar energy and energy conservation (halving the consumption of individual appliances), the Amer-

[1]This is a fictional presentation created by Jim Duke for the Office of Technology Assessment. It reflects the personal opinions of the author.

icans were still energy guzzlers. They now had electric nail clippers, electric combs, and electric toothpicks, and they had to recharge their electric cars in offpeak hours with their palm oil and ethanol-fueled generators. These were located on offshore barges for the receipt of the barrels of ethanol and palm oil flowing in from the neotropics. The gringo still heats his home 6 months of the year to 72° F and cools it 6 months of the year to 62° F, wearing short sleeves in the wintertime around the house and coat and tie during his air-conditioned summer, Jim Duke said you could fuel America with sewage-irrigated biomass (if Americans went vegetarian) and Melvin Calvin said Arizona planted to the petroleum plant *(Euphorbia lathyris)* could satisfy the energy needs of the United States. Szego and Kemp said you could do it with Btu bushes. But America went on and paved its bottomlands, its most productive farmland, which now sells at $200,000 per hectare. No one really knew who was right, Should they have believed Vergara and Pimentel who said that all the biomass in the United States would support only 2 1/2 percent of their energy needs (while in 1980 concluded that biomass already supplied 2 percent of U.S. energy consumption and could supply up to 20 percent by 2000), or estimates of 10 percent (like Dugas came up within California), or those who said U.S. consumption about equals the net annual storage of solar energy in U.S. biomass, or Vietmeyer who accepts Calvin's suggestion that Arizona planted with petroleum plants could fuel all the United States?

There aren't too many animals on Magic Mountain and these are there more for biocontrol than for meat. Sam Swindell has a bunch of pigs that are rotated from one alluvial farm to another when the nutgrass gets out of control. Seems that the nutgrass was evolving just as fast as the herbicides. The last generation of nutgrass herbicides reduced yields of the crop by 50 percent. One group of hippies down in Guyana had started making a beverage (Chufa Cola) out of the nutgrass tubers, using the aerial biomass to generate the energy to run their operation. But nutgrass got so rare that Chufa Cola is barely competitive with Coca Cola anymore. Tommy Tucker intercrops turkeys with the legumes in his orchards, largely to control weeds as suggested by Surguladze. Joe Groats has a few goats he stakes out whenever the tropical Rubus the gringos introduced for nitrogen fixation gets out of hand.

The Rice-Azolla farmers let the geese help the Azolla keep down the other weeds, while the grass carp keeps down the Azolla and finishes off the zeolite-treated human refuse. They're returning the residues from the essential oil still provided by AID to the soil. But not just any residue anywhere. Seems that back in 1985, Duke quit talking and computerized all that data showing which plants (and their residues) had positive effects like alfalfa on crop yields and which had negative effects on crops and weeds. Getting 3 MT of leaf protein from alfalfa left a lot of spent residue around, even after ethanol generation. Some of the triacontinol persisted even in these second generation residues, enough to boost the yields of tomatoes by 10 percent, beans by 15 percent. With the computerized systems analysis of the allelochemic insecticides and fungicidal, as well as insect-regulatory aspects of spent residues, there was real planning as to distribution of the allelopathic residues. The locals went all out on Vietmeyer's winged bean when they found germplasm for seeds resistant to bruchids. In the past, bruchids had consumed half of their stored grain. This minor discovery had the effect of doubling their yields of dry beans. Besides, they got more nitrogen fixed than from the haricot bean, and edible roots instead of poisonous roots.

Following up on McKell's suggestion back in 1980, the Magic Mountaineers are using native species in their multitiered agroecosystems. Ipecac, here, like ginseng to the north, only grows in the shade. The natives are using byproducts from their overstory tonka bean (coumarin producer *Dipteryx odorata)* to stimulate rooting of new cuttings of ipecac *(Cephaelis ipecacuanha)* as they harvest roots of the older ipecac. Coumarin has been shown to stimulate cuttings. Both these species, like shade-loving *Piper dariense* (used for toothache and fish poison), are adapted to the cooler, higher slopes of the Subtropical Montane Forests.

Gradually, tonka beans and oil-producing palms and diesel trees are being introduced into the forest canopy as other species are felled or die. Magic Mountaineers still don't believe Calvin's estimates that they can get 125 barrels of "diesel" per hectare from their "diesel trees," *Copaifera* spp., but the resin is now selling for $10 a kilo and they can harvest renewably a few hundred dollars worth a year as they are harvesting ipecac, chicle, rubber, ivory palm, quinine, and tonka beans from TMF species over on Meyer's Mountain. The nature lovers still prefer to gather their items renewably from Meyer's Mountain National Forest, while the homebodies are transplanting their species as money-making trees for the upper story of their agroforestry enterprises.

One of the Magic Mountaineers was raising crocodiles for the export market in his water chestnut patch. If harvested young, they did not thrash around too much and mess up his water chestnuts.

However, the crocodiles did cut his fish and prawn yield by 50 percent. He had trouble getting his hides shipped directly to the United States Endangered species authorities thought that cultivating crocodiles might endanger them in the wild. Another Magic Mountaineer had been exporting butterflies to the United States until the endangered species people shut off the port. When the farmer abandoned his operation, two species went extinct, as far as Magic Mountain was concerned. Perhaps they still exist over on Meyer's Mountain. Another farmer was exporting amaranth seed to the U.S. health food market until the regulators stopped him, trying to avoid the importation of another weed, Boy Scouts back in the United States quietly filled this market by harvesting the amaranth seeds from weedy cornfields.

On the gravelly limestone ridge, where the 4 m annual rainfall quickly percolated through, some of Felker's Prosopis was doing well, but the natives still preferred the tamarinds *(Dialium, Tamarindus).* They tend to vary their diets with other legumes, some mentioned by Felker; Cassia, Enterolobium, Hymenaea, Inga, Parkia, Prosopis, The Prosopis yield of 12 MT/ha did not carry so much weight here in the humid tropics as it did back on the Chilean desert. One Chilean tree was reported to yield at the rate of 12,700 kg fruit/ha, clearly a good yield for the desert. But none of the Arid Tropical species compete well in the Humid Tropics and vice versa,

A cord of mesquite will yield 30 million Btu compared to 25 million Btu from a ton of coal. Arizona pinon-juniper yields 18 million Btu. And Magic Mountaineers, still cooking with wood, were impressed by Vietmeyer's statement that a hectare of Leucaena would yield 10 times as much wood as a well-managed pine plantation. The new fuel-efficient stoves the Swedes sent cut down on firewood consumption, leaving them with less ash to fertilize their vegetable plots.

Some of the natives of Magic Mountain are not fond of Leucaena, some of them even lamenting that they had sown it for cover on the old landslide. Its seeds were coming up everywhere, but it only seems to be a real weed on the scarp. Nitrogen is, after water, the most frequent limiting factor in the Tropics, so Leucaena is viewed by some as a good N source. Our Magic Mountaineers were impressed with Halliday's statement that biological nitrogen fixation is "economically more sound and environmentally more acceptable than nitrogen fertilizer use in agriculture" and his statistics; most legumes fix 100 kg/ha, with Leucaena at 350 kg/ha, and a potential of 800 kg/ha, Bill Liebhardt estimated Rhizobial Nitrogen fixation of pure strands of Leucaena at 50 to 900 kg/ha. Still, certain government agencies sent millions of dollars worth of N to the Third World, when appropriately inoculated legumes, cheaper to distribute, would have done the job renewably. Efficiency was the excuse, it takes less paperwork to spend $100 million at one fell swoop than to make 100 separate million dollar investments.

The Chinese on the steep slopes of the wet side of the mountain are intercropping azolla, rice, fish and duck, in their intricately terraced rice paddies. They were getting 15 MT rice per hectare as Clark had reported in 1980. They were not getting 150 MT dry weight of Azolla as suggested by Clark, but they had devised a system for raking off the bulk of the Azolla every 10 days, after it doubled its biomass, and adding the biomass as a mulch to truck gardens on the ferralsols. And they sell a lot of azolla-fed fish and ducks off their rice terraces. There is a persistent rumor that they are adding night soil to their rice-azolla farms. But their terraced slopes are as productive as the alluvial bottomland,

Duke had always pushed the sunchoke (sunflower X artichoke) as a biomass candidate for the temperate zone. The Chinese have squeezed it, like so many other temperate species, into the humid tropics. Sunchoke accomplished some of the things enthusiasts for perennial corn were pushing back in the 1980s. The roots are perennial and produce at least 20 MT/ha edible root, leaving behind more than enough to reseed itself and feed the last of the wild peccaries. The annual sunflower parent would have to be replanted but not the artichoke, it kept coming back like a song, more like a weed. One farmer who wishes to go into a different agrotechnology had to borrow the biocontrol pigs to clear his land of sunchokes. Chinese learned to add the raw artichoke to Chinese dishes to substitute for water chestnut. It also turns out that the aerial biomass, cut three or four times a year, was good for leaf protein and ethanol synthesis, Still this sunchoke did not yield as highly as some of the other scenarios. Some of the Magic Mountaineers accused Johnny Sunchokeseed of introducing a weed to the Tropics, Take it home, yankee.

Down in the swamps, the natives were producing closer to the lower than the upper predictions of DOE back in 1980, 60 to 270 barrels of ethanol per hectare from cattails. They were getting higher yields from some of the native swamp species Acrostichum, Dieffenbachia, Gynerium, Erythrina,

Montrichardia, Panicum and Pennisetum, species that DOE had not even considered.

Before Panama took over the canal, U.S. germplasm specialists provided many useful palms for trial on Magic Mountain. Finally the Orbignya from Brazil was bearing seed, but the smuggled seed had triggered an incident. Brazil broke relations with Panama and the United States for collecting germplasm without a permit. Back in the 1980s at a congressional OTA workshop, Duke had wondered about some of Schultes' optimistic numbers for *Orbignya martiana:* trees reported to yield more than a MT of fruit per year, 10 percent of which was kernel, 50 percent of which was oil for a yield of 40 kg oil per tree or a barrel of oil for every 4 trees, accompanied by 40 kg protein per tree and perhaps 350 kg carbohydrate per tree. Duke feared these projections were optimistic, like Melvin Calvin's estimates of gopherweed oil. Still he recommended that OTA urge investigation of all palms because many are adapted to marginal tropical habitats. Some of the Magic Mountaineers did get yields almost that high with trees at 100 to 200 trees per hectare. Above this, per-tree yields dropped off. Still, some of our Magic Mountaineers are getting 100 barrels of palm oil per hectare on marginal soils. There was almost as much protein, and more carbohydrates for ethanol production.

Magic Mountaineers had really been impressed with Mumpton's zeolites. Zeolites increased their fish biomass by 10 percent with 5 percent clinoptilolite, chicken feed efficiencies by 20 percent with 10 percent zeolite, beef profitability by 20 percent, calf growth by 20 percent with 5 percent zeolite, and swine growth by 25 to 30 percent with 5 percent clinoptilolite. They are using the clinoptilolite to treat feces in their portajohns, lessening the odor.

Zeolites have made a big difference in farming, too. The nitrogen is held longer after the zeolite is applied to the soil. Near Panama City, the zeolites were being imported from the interior to slowdown plant uptake of heavy metals in the sewage sludge energy farms and in the purification of low-Btu methane produced by anaerobic fermentation of beef excrement in the Hamburger Farm.

One oilpalm farmer with several dozen hectares persisted in grazing beef and milk cows in the partial shade of his oil palms and coconuts. He heard that he could increase his oil yields by 2 MT (about 6 barrels) per hectare simply by interplanting with tropical kudzu and butterfly pea. He found that by limited grazing, he could maintain his oil production. When asked what he was doing with his oil and cattle he said, "Those carnivorous Americans are still after our cheap hamburgers. Why at some joints you can get a centigrammer (centigram hamburger) for $2.00. Some people hint that it's laced with palm protein, one of our byproducts here. And the Americans are running their soybean farms with diesel tractors fueled with palmoil. That is considerably cheaper than soyoil." "And what about your milk?""Oh, we dehydrate that and send it to the Americans too. "

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