Tough Habit to Break

Elephant grass (Pennisetum purpureum) UF-IFAS, CENTER FOR AQUATIC & INVASIVE PLANTS

by Jim Burch

Crops that can be harvested as renewable sources of energy are currently of great interest to the world's agricultural and other business communities. Florida is well suited for agriculture, but crops considered as biofuels often are not native to this state, so that large-scale growth of exotic plants is a significant possibility. Curiously, a similar move to import plants was underway about one hundred years ago, and this contributed to the costly exotic plant invasions with which we contend today. The twentieth century philosopher Santayana suggested, "Habit is stronger than reason." Are we about to try this experiment again?

Plants as Alternative Energy Sources

Unless you have been living on a raft, you know that petroleum products have generated a lot of attention with recent price increases. At some level we knew this would happen, with more demand for energy and increasingly inaccessible resources. We have been instructed from grade school that energy resources are finite, and that someday they would be in short supply. This concept is easy to understand, but difficult to recognize until the squeeze is really on and our wallets are pinched.

Most of the energy we use originated as solar electromagnetic energy (light). Long ago, photosynthetic autotrophs, and later plants, evolved the chemical process of photosynthesis in response to available light energy. By temporarily winding entropy backwards, photosynthesis allows energy to be sequestered and synthesized into useable, energy-rich compounds. This process is the basis of most food webs, forests, and oil fields. Using the energy stored in plants to supplement our power sources is an attractive alternative to fossil fuels.

The idea of using renewable, self-sustaining plants to gather our energy makes sense, but many related things should be considered. Several different plant species have been touted as new biofuel resources. The plants of interest all have high rates of carbon sequestration, are fast growing, require little care, and generally thrive in conditions adverse to other plants. These plants are quickly renewable and efficiently gather solar radiation, converting it to carbon-based energy-carrying compounds that we can use.

Non-native plants, however, carry potential problems when associated with native biological communities. This can be especially true with grasses. The Florida Exotic Pest Plant Council's (FLEPPC) 2007 List of Invasive Plant Species indicates seven Category I and four Category II plants that are grasses. The Pacific Risk Assessment Evaluations (U.S. Forest Service 2007) lists 224 exotic grasses in the Pacific Islands area, including Hawaii and Australia. Of these, 72 were evaluated for risk of invasiveness on the islands; 57 (79.2%) were rated "high risk", 5 (6.9%) were rated "low risk", and 10 (13.9%) require further study. Some grasses are tenacious, competitive, and displace natives where they are introduced; it is appropriate that caution and vigilance accompany these introductions.

A Few Candidate Plants

Development of useable material from plants usually involves the production of fuel to power electric generators or other combustion-driven machinery. Common methods include production of ethanol by fermentation of sugars, production of bio-oil, or production of cellulose-based biomass. All of these may be used as fuel to produce heat, and subsequent mechanical

energy. Several plants have been considered as renewable energy resources; many of these are exotic grasses.

Elephant grass (*Pennisetum purpureum*) contains little sugar in its tissues but it can be converted to bio-oil by pyrogenic processes with charcoal left over, both of which can be used as fuel.

Sugarcane (*Saccharum officinarum*) may not be as effective an energy source as other grasses. Duke (1983), citing others, questioned the efficacy of ethanol production as an energy source; this study is 25 years old, so that more recent information should be considered. However, the comparisons cited in this study were based on energy requirements to produce ethanol, which presumably have not changed. If this is true, the yield of ethanol energy is low considering the energy required for production.

Arundo (*Arundo donax*) grows rapidly but does not produce seeds. Herbivory is practically unknown for this plant. This grass also produces fibers that can be used to produce high quality paper. Although proponents of arundo as biofuel claim that a six-year evaluation in Florida indicated no invasive tendencies (Schill 2009), land managers in Florida show great concern. At least one company has indicated serious interest in producing biomass fuel for power plants from over 20,000 acres of planted arundo; arundo has become invasive in California, Texas and elsewhere where water-borne vegetative propagules became established in large areas. Even if arundo is planted in dry areas of Florida, this state is prone to hurricanes that could blow plant fragments to wet areas. This grass is a major concern in California because it can change fire regimes and displace native plant communities that affect approximately ten animal species listed for protection (Dudley undated). Spencer et al (2008) found that arundo plants from Florida, Texas, and California grew equally well under similar conditions, and no differences in growth characteristics were found that would suggest different invasive potential and impact on resident species. The Florida Native Plant Society (www.fnps.org) produced a lengthy and well-researched policy statement opposing the use of arundo as a bio-energy crop, based on its invasive potential and histories in other areas.

Jatropha (*Jatropha curcas*), a broad-leaf Euphorb, yields oil from its seeds, so that bio-diesel or other oil products can be produced. However, this plant is poisonous to humans, and is invasive in many biological communities. Australia has banned the plant since 2006, citing potential environmental problems. The yield of useable products from this plant is attractive, but it requires significant labor to produce. Until this is overcome, large scale production is questionable.

Category I Invasive, Florida Exotic Pest Plant Council (FLEPPC): invasive exotics which are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives. This definition does not rely on the economic severity or geographic range of the problem, but on the documented ecological damage caused.

Category II Invasive, FLEPPC: invasive exotics that have increased in abundance or frequency but have not yet altered Florida plant communities to the extent shown by Category I species. These species may become ranked Category I if ecological damage is demonstrated.

Fairchild and Other Plant Importers

About one hundred years ago a similar move to import plants into Florida, and the United States in general, occurred. The idea was to improve agricultural production by capitalizing on crop attributes found in plants from other areas. This, in part, led to some of the exotic plant management problems we now confront.

David Fairchild's autobiography (Fairchild 1938) on many pages reads like a "Who's Who" of early Miami pioneer families, world famous travelers, scientists, and plant importers. Fairchild was perhaps the best known of the plant explorers, and in the early 1900s he was appointed Agricultural Explorer in Charge for the Foreign Seed and Plant Introduction section of the U.S. Department of Agriculture, a position he held for over twenty years. As part of the responsibilities associated with this position, he administered several plant introduction stations in the United States and in a few other countries, as well. These facilities dealt with importing plants from around the world, and studying them to determine what characters would be most advantageous for propagation and harvest in this country. A few were in the Miami area, including the well known Chapman Field Plant Introduction Facility on Old Cutler Road, which primarily dealt with tropical plants.

Much of the imported plant material was selected because it demonstrated promise for improving agriculture in the United States. At the time much of the United States was still culturally and economically associated with agriculture, so that improving crops or developing new agriculture was a reasonable and essential activity; importing plants with desirable qualities for agriculture made sense. Also, a need for rubber was developing in the 1900s with the advent of automobiles, and this became particularly important as part of national security in the years leading to U.S. involvement in WW I. Several candidate plants associated with rubber production were imported. This likely opened possibilities for consideration and import of other tropical crop plants. In general, the plants that were brought in offered increased quantity and diversity of food production, higher quality feed for livestock, building and manufacturing materials, and other products consumed or sold. Importing these plants was a good idea at the time.

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General Category	Temperate Origin	Tropical Origin	Total	Percent
Forage Crops	343	115	458	30.6
Agricultural Crops	414	370	784	52.4
Landscape	37	69	106	7.1
House Plants	4	1	5	0.3
Textiles and dyes	10	8	18	1.2
Medicine	16	7	23	1.5
Construction, forestry	29	47	76	5.1
Cosmetics	0	4	4	0.3
Research	4	19	23	1.5
Total	857	640	1497	100

Table 1. General categories of plants introduced into the United States in 1909. A total of 1,497 plant introductions into the United States occurred in 1909 and many of these were of materials with tropical origins that may have been introduced to facilities in Florida. Most of these plants were crop or forage candidates, but a few were possible landscape or other uses.

Fairchild wrote exuberantly about the virtues of *Casuarina* spp. (two species now on the FLEPPC Category I list; one species on the FLEPPC Category II list), Brazilian pepper (Category I), kudzu (Category I), and other imports. He made equally positive comments on many other plants that have become valuable to agriculture, or have not become invasive. Attention was given to the FLEPPC-listed species paragrass (*Urochloa mutica*), and rubbervine (*Cryptostegia madagascariensis*), and other plants as potential Everglades colonizers. An area dominated by cajeput (*Melaleuca quinquenervia*) (Category I) was described as a previously small population in Dade County, started only a few years before, that had grown and expanded to cover many acres, smothering a citrus grove; the plant explorer mused that the individual who might first transplant these trees for sale would be favorably received as a discoverer.

S. H. Richmond warned that *Leucaena leucocephala* (Category II) would become a weed in southern Florida (Fairchild 1938) and by the 1930s it had, but Fairchild minimized this because, as a legume, it enriches the soil, and the tree produces good firewood. This tree is now marginally invasive in southern Florida, but enormously problematic on many Caribbean islands. Clearly, the idea of ecological perturbations caused by exotic plant populations in Florida was not well developed in the early twentieth century and, if it was considered, it seems that the anticipated benefits outweighed potential problems.

The plant importers did their jobs well and documented the arrival of thousands of propagules from hundreds of plant types annually for many years; in part of 1914 they averaged thirteen introductions per day. One hundred years ago (1909) the U. S. Department of Agriculture Bureau of Plant Industry records indicate that 1,497 introductions were made (sequential numbering of records suggests that over 1,600 introductions occurred, but a count of introductions totaled 1,497). Eighty-three percent of the plants introduced were associated with agriculture and forage crop improvements; another 8 percent were associated with the textile industry, medicine, and construction or forestry industries, so that well over ninety percent of plant imports were associated with tangible goods and services. The remaining plants that were imported were used for aesthetic enhancements, and a few were brought in for research, as some potential was noted for characters possessed by these plants.

About 43 percent of imports in 1909 had a tropical affinity, so that many of these were likely to have arrived in Florida (southern California also received some of these imports). Of these, at least two now are classified as FLEPPC Category I invasives, and three plants are classified as Category II. The number of imported plants that may be invasive in other states is not determined here.

Conclusion

About a century ago, we imported plants from around the world with an eye toward improving things for society. Now we may question the value of those actions. Sharp-penciled accounting can indicate the money involved, but it is not easy to assign dollar amounts to changes in natural areas that also occurred. Clearly, our society has a need for different sources of energy, and several agricultural crops have potential here in Florida. The importation of plants for energy production differs from previous plant import strategies, as comparatively fewer species are being considered. Nevertheless, these potential introductions beg caution. We confront the possibility of massive propagation of large, non-native grasses and other plants as energy sources. With the interest in producing energy-related plant products, the question, "Will it be worth it?" is reasonable. The twentieth century philosopher Santayana also stated: "Those who do not remember the past are condemned to repeat it."

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