Breeding crops for sustainable pesticide-free production in Hawaii

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Sweet and field corns bred at CTAHR can be grown pesticide-free in Hawaii. This is the result of a breeding program dedicated to the complete avoidance of pesticides on the crop itself (Brewbaker, 2003). This commitment was made in 1965 as we dedicated three fields at Waimanalo Research Station for pesticide-free corn breeding.

We were urged on by dedicated UH scientist, James C. Gilbert, whose concept of "pyramiding genes for resistance" undergirded his breeding of improved tropical varieties of tomatoes, eggplant, edamame soybeans and other crops. Pyramiding represented the successive or simultaneous addition of genes to a crop that increased its range of tolerance to viruses, bacteria, fungi and insect pests.

For some years we rued this commitment, for it posed problems requiring long-term research. We discovered that all temperate American corn varieties were highly susceptible to the following problems, and were useless in Hawaii's corn breeding:

Maize Mosaic Virus is transmitted by the leafhopper, *Peregrinus maidis*. This insect and virus continue to demand weekly pesticide applications by Hawaii's corn seed industry, in order to avoid hopper-burn and the killing virus. However, all of Hawaii's varieties were bred with tropical genes that ensure high tolerance or resistance Southern Rust (*Puccinia polysora*); a tropical asexual rust that is represented by much racial diversity in Hawaii. All Hawaii-bred varieties carry genes for tolerance *Fusarium* Rots. *F. verticilliodes* causes kernel rots and seedling mortality of all temperate American sweet corns and most of its field corns. Many years of recurrent selection were required to pyramid genes for tolerance to this omnipresent fungus. In addition we found that many temperate corn varieties could not yield well under the short days of tropics and were susceptible to diseases like *Turcicum* blight, Common Rust, Sugarcane Mosaic Virus, Brown Spot and to insect pests such as the corn earworm (Brewbaker, 1979).

Scientists recognize that corn (*Zea mays* L.) evolved in the tropics, where it is represented by genetic diversity greatly exceeding that in the Corn Belt (Brewbaker, 1979). Varieties from temperate regions represent an evolved set of germplasm that is quite unique. They are susceptible to most tropical diseases, with soft denty kernels, lacking daylength sensitivity, and the sweet corns are all highly tillering (gene gt = grassy tiller). This evolutionary selection was accompanied by loss of many genes that

are required for sustainable high yields in the tropics, where pests and diseases thrive year-round. The same evolutionary trend has affected tropically-evolved crops like potatoes, tomatoes, peppers, eggplant and beans as they were bred for temperate America.

The most significant core concept in growing crops "organically" and "sustainably" is freedom from pesticides. The organic-production concept could have evolved only in temperate climates, where winter performs its act of ablution of pests, weeds and diseases. Sustainability of crop production in the tropics faces a host of problems unknown on my boyhood farm in Colorado, where we grew every crop organically in the 30's and 40's (and shoveled a lot of cow manure). However, Colorado's winter performed its annual miracle of cleansing by minimizing problems of diseases, insect pests and weeds. The plant breeder can offer this same miracle of cleansing for food crops in the tropics by pyramiding genes for tolerance, a la Jim Gilbert.

Public plant breeders have recently been labeled a "dying breed" in national media, as much crop improvement has moved to the private sector. However, many tropical plants attract little or no investment by this private sector for the obvious reason that financial returns are negligible to them. For many crops in the tropics, it will continue to be impossible for sustainable and organic production to be economically successful without major investment in breeding. This is due in large part to the ongoing global movement and evolution of new viruses, bacteria, fungi and insect pests.

Fortunately, many of Hawaii's tropical crops--often highly polyploid perennials--are virtually free of diseases and pests. This includes crops like the *leucaenas* (koa haoles) on which I work, the *moringas* and guinea grasses and sweet potatoes. But with most food crops there will be continuing demand for breeding and selection to meet the challenges of evolving pests and diseases. Achieving this sustainability will demand major public investment.

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References: Brewbaker, J. L. 1979. Diseases of maize in the wet lowland tropics and the collapse of the Classic Maya civilization. Economic Botany 33:101-118.
Brewbaker, J. L. 2003. Corn Production in the Tropics: The Hawaii Experience. CTAHR Publication. 74 pp.