

THE DARK GREEN REVOLUTION

The Next Wave in Agriculture

by David Kennedy

FROM A HILLSIDE overlooking forests, apple orchards and corn fields, the forest appeared as a lush, unbroken carpet of green, while the young corn looked like green lines marked across a sheet of brown paper. Clearly the forest had more leaves basking in the sunshine than the corn. By August the verdant forest was looking down upon a cornfield that had already produced all the corn it could and now held lifeless amber waves of grain drying in prime farmland. Yet this cornfield was the culmination of modern agricultural science – dependent on tractors, hybrid seeds, synthetic fertilizers, and pesticides – while the green forest was simply neglected and ignored.

What does this mean? Continuing to expand the production of grains is frequently cited as the only hope of averting mass starvation as the world population grows toward six billion people. Can we learn something from the forest that will help us feed ourselves without the increasing dependence on petroleum fuel and agricultural chemicals necessitated by ever larger grain yields?



LEAF FOR LIFE



An acre of forest has more surface area of green leaves more of the year than an acre in grain crops. This enables it to produce several times more biomass, or living substance. The ability of green leaves to capture the radiant energy of sunshine and convert it to food and fiber is the basis of life on Earth. We don't eat wood but we can produce more food with less effort if we think more about the natural advantages of forests over grains.

Almost all the food we eat is formed in the green leaves of plants. This is the base of the human food chain. If we could learn

to eat just the soft green leaves we could avoid the energy losses required to transfer the food to seeds, dry the seeds in the field, then soften the seeds by cooking them in water. It is also worth noting that much of the grain produced in the world, perhaps 25%, is lost to insects, birds, rodents, and mold before reaching the table. The net loss of food for humans is even greater if these seeds are fed to animals, as this moves us another link away from the base of our food chain.

Unfortunately, while leaf crops produce in abundance, they are less than convenient

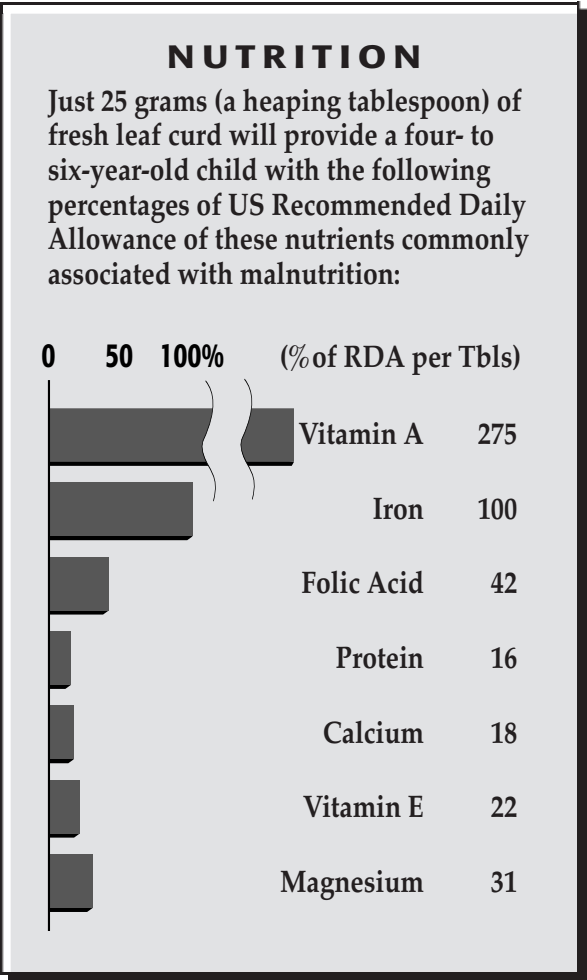
FLEXIBILITY

- World weather patterns are changing, and erratic rainfall is making the growing of grains and beans an increasingly risky undertaking in much of the world. Fast growing leaf crops, like amaranth, carinata, and cowpea can produce crops in as little as 30 days, where grains and beans demand several months of ample soil moisture.
- The composition, texture and flavor of leaf concentrate is very similar regardless of the leaves used to make it. This means that leaf concentrate foods can be made from dozens or even hundreds of different leaf crops.
- Leaf concentrate is ideally suited for integration into the small mixed farming techniques that can simulate the diversity and productivity of natural forests and prairies. It can be incorporated into alley cropping, where annuals are grown between rows of trees or shrubs, or strip cropping, where two or more crops are grown in strips rather than rows and the crops are rotated among the strips.
- Some of the best leaf concentrate crops are multi-purpose plants. For example, the immature beans from cowpeas can be eaten as vegetables and the mature seeds eaten as dried beans if the plants go past the ideal leaf harvest stage.



as a source of human food (though not as inconvenient as wood). The role of green leaves in the human diet has been very limited because of their strong flavors, high water and fiber content, and perishability. These limitations have always offset the many environmental, economic and nutritional advantages of eating leaf crops directly. Even the legendary feats of a spinach powered Popeye the Sailor could not convince many people to greatly increase their consumption of dark green leafy vegetables. The difficulties of incorporating large amounts of leafy greens into the human diet are well known by nutritionists and parents of young children around the world.

What is not well known is that for over 200 years there has been a simple technique for turning hundreds of different leaf crops into a food that can be stored and that is low in moisture and fiber and has a mild flavor. This food, called leaf concentrate or leaf curd, is made by grinding the green leaves of certain plants, pressing the juice from these ground leaves and heating the leaf juice. By the time the juice reaches the boiling point a green curd, like cottage cheese or tofu, forms and floats to the top. This is skimmed off and pressed to remove



as much liquid as possible.

The pressed leaf curd is about 60% moisture and 27% good quality protein. It is the richest known source of beta-carotene (which is converted to vitamin A)



and one of the richest sources of iron, besides containing reasonable quantities of a range of other nutrients. It can be preserved by drying or combining with sugar or salt.

The technique of making leaf concentrate is likely to become much better known in the near future because of three ominous trends that dominate the world food situation:

1. All the present indications are that the human population will continue to increase rapidly, probably reaching 6 billion by the turn of the century and 10 billion

before leveling off. Most of this population growth will be in humid tropical countries with little in the way of capital or technological assets to apply towards improving their food systems.

2. After several decades of rapid growth, world grain yields are reaching a plateau. The Worldwatch Institute is projecting an 8% reduction in per person availability of food grains over the 1990's. This could mean a life threatening rise in grain prices for the estimated one billion people that spend three-quarters of their income on basic food now.

3. Further rises in grain yield are coming at the expense of greater energy costs and environmental damage. Twenty years ago a ton of fertilizer would increase grain yield by ten tons; today it makes less than half that impact. Much of the world's best grain producing land is being eroded or losing its structure, and water holding capacity as huge crops are removed and organic matter is not replaced. Planting fragile hillside, rainforest, and semi-arid land temporarily enlarges our grain yield, but causes serious long term environmental damage. We are ushering in a no-win situation in which the natural resources required to produce ever greater grain yield are being

ENERGY

- An acre of leaf crop like alfalfa typically requires less than 1/2 the energy inputs of raising grains over the growing season, while producing far greater quantities of essential nutrients.
- Beans, the principal high protein food of the world's poor, require hours of cooking, often with increasingly scarce fuelwood. Leaf concentrate is a superior protein source in both quantity and quality, though it takes much less energy to prepare.
- The fiber left from making leaf concentrate can be used for generating biogas for cooking. The residual liquid can be used for ethanol production.



rapidly damaged by the very process of raising that grain.

Put another way, the Law of Diminishing Returns suggests that we must not rely so heavily on grains to feed our rapidly growing population. This presents a very challenging reality. We must quickly identify and put into use alternative methods capable of producing far more food than current agricultural practices and doing so in a manner that is far less damaging to the natural environment. Anything less will mean massive destruction of food producing lands and intolerable levels of human suffering.

While grains will continue to be an important food, they cannot be expected to continue carrying the entire burden of feeding this vastly increased human population. Dramatically increasing the availability of animal based foods would probably have even greater negative impact on the environment, as we have seen with the overgrazing of arid lands and the clearing of rainforests for beef pasture. Most of the "high tech" food ideas of the sixties – like growing chlorella algae in irradiated plastic tubing, or single cell proteins in petroleum wastes – have so far been impractical and expensive.

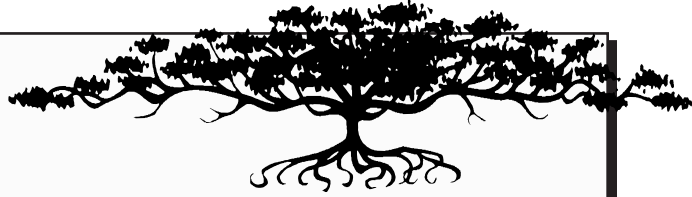
AGRICULTURAL CHEMICALS

- Nitrogen fertilizer for grain crops is the biggest energy cost in modern agriculture, and is increasingly a source of groundwater pollution. Alfalfa, cowpeas, and other leguminous leaf crops biologically fix nitrogen from the air. They require no additional nitrogen and they often provide it free of charge for grain crops that follow in rotation.
- Pesticide use is minimal because leaf crops need to be protected for a far shorter period of time than seed or fruit crops. There is no need for insecticides often used to make vegetables and fruits visually appealing for market, as the leaf crop is ground to pulp immediately after harvest.

Because it can make more direct use of the food formed by the green leaves, a leaf concentrate system can produce more nutrients per acre than any other agricultural system. Still there are less expensive sources of calories, and calories are often lacking in the diets of the poor. There are several well known crops that produce

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TREES



TREE CROPS ARE ESSENTIAL to any plan to increase food supplies dramatically while protecting the environment.

Trees can thrive on hillsides and arid lands where grain crops can't be successfully grown. Their deep root systems can find water and minerals that annual plants can't reach. Leaf concentrate crops can be used to nurse tree crops, conserving and enriching the soil and producing food and animal feed, while the slower growing tree crops get established. This is critical to reforestation schemes in areas of poverty and malnutrition. Hungry people are unable to wait for several year for tree crops to yield an income.

A HIGH AND STABLE OUTPUT of calories can be derived from many different tree crops. For example, pejobaye, breadfruit, and jackfruit, can produce more calories per acre than grains in a far more sustainable system. Breadfruit and jackfruit can produce huge yields (up to one ton per tree) of fruit rich in carbohydrates that are similar in taste and texture to potatoes when cooked. Combining these starchy tree foods with leaf concentrate could provide superior nutrition to the grain based diet of most people in tropical societies.

PERENNIAL EXPORT CROPS like coffee, cocoa, annato, pepper, rubber, brazil nuts, cashews, and oranges can also be grown with a leguminous leaf concentrate crop, like cowpeas, to provide food and feed while these crops get established. These trees and shrubs can bring in cash needed to raise the standard of living without damaging food producing lands the way sugar cane and cotton growing do.

MANY TREES AND SHRUBS are already important forage crops. Some of these, like Moringa, Sesbania, Jocote, Mulberry, Alder, and Alianthus are promising sources for making leaf concentrate. Work has already begun screening hundreds of tropical tree species as possible leaf concentrate sources.



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more calories per acre than grains, and that can do so with far less energy inputs. These include starchy root crops like cassava and taro, tree crops like breadfruit and jackfruit, and plantains, or starchy cooking bananas.

While these foods are usually available at low cost, they don't contain the protein or range of other nutrients to equal the nutritional quality of grain based diets. However, by combining these inexpensive sources of carbohydrates with leaf concentrate, it is quite possible to create a superior diet with reduced environmental impact. This is a food security strategy that should be given more consideration and support immediately.

Leaf concentrate certainly cannot address or resolve this entire problem, and there are some locations where it won't work very well at all. In arid lands the water requirements of lush leaf crops are usually excessive and focusing on improving water thrifty crops like sorghum, millet, buffalo gourd, tepary beans, and acacias is a more realistic strategy. It is, nonetheless, an important and underutilized tool that anyone working on hunger and environmental problems should be aware of.

In addition to being a pragmatic step in

RAINFOREST BEEF

Rapid destruction of tropical rainforest for cattle raising is a profound threat to the health of the planet. Tropical legumes, like cowpeas or butterfly peas, can produce huge leaf crops on small parcels of land. Leaf concentrate made from them can improve the human diet, while cattle or goats can be raised mainly on the residual fiber. This is economically as well as environmentally preferable to the vast spread of very poor quality cattle pasture that result from clearing rainforest.

the direction of sustainable food supply, leaf concentrate can be a very instructive metaphor for thinking about agriculture. As we come to understand how the energy flowing through a system is the force that organizes that system, the green leaf, as the prime transformer of solar energy, will come to symbolize a new age of agriculture. Leaf concentrate is a catalytic idea that can accelerate this process. It can ease the passage to an more ecological agriculture by offering immediate relief to people who are today hungry and desperate, while simultaneously developing food systems that can bring enduring abundance.



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