CHAPTER 3

THE PERMACULTURE SOLUTION TO FOSSIL FUEL DEPENDENCY

As we showed in the last chapter, industrial agriculture and its components—oil-based fertilizers, pesticides, and herbicides—are harmful to the planet. A nationwide switch to organic farming is in order. But it can't work if we maintain a monoculture-based system, with its present emphasis on corn farming. Much of America's farmland is below 2% organic matter. At 2%, the soil biology collapses—and, with it, the fertility needed to grow crops. More and more chemical fertilizer is needed to prop up production on sterilized soil.

THE "GREEN REVOLUTION" AND PERMACULTURE

A lot of people think that the "Green Revolution"—marked by the advent of monocultures, pesticides, herbicides, and chemical fertilizers some 60 years ago—produces more food per acre than older methods of agriculture. It emphatically does not. In fact, a Mexican campesino using simple hand tools to grow a polyculture of corn, beans, and squash can produce, on a dry-weight basis, far more food per acre than the farmer of the most modern U.S. Midwestern cornfield—food worth far more money on a net basis.[1] Unlike subsidized Green Revolution farmers, the campesino would not survive if his farming were only 30% efficient in using its major energy input (sunlight) or if it were dependent on expensive consumable products (herbicides, pesticides, fertilizers) that damaged the operating equipment (soil).

More than a half-century of this so-called Green Revolution has created our current urgent need for permaculture ethanol systems to solve the many agricultural and energy woes left in its wake. My hope is that an appeal to farmers' bottom lines, as well as a national consensus for a cleaner environment, will motivate change toward permaculture.

As you will see later in this book, there are many crops that can produce much larger amounts of

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Fig. 3-1

alcohol fuel than a monocultural crop such as corn. A key to the success of the permaculture system is crop rotation, where different nutrients are used each season and nothing becomes depleted. Right now, the only common rotation in the Midwest consists of corn and soybeans. If you had four to eight different energy crops rotating, the demands on the soil would be very much reduced and could even be complementary.

"Then why should the farmer pay an ever-increasing price for gasoline when he can produce all the alcohol he needs and a lot more on his own farm?"

—HENRY FORD, *DETROIT NEWS*, DECEMBER 13, 1916

As long as much of the organic matter from production is returned to the soil—as in permaculture—an agricultural system will increase in fertility each year. The present agricultural system destroys topsoil and, therefore, fertility. Once the level of organic matter in the soil reaches around 5%, organic farmers need only about five tons of compost per acre per year to maintain fertility. Spread evenly over an acre, this would appear as a light dusting. With more organic matter than that, farmers would build topsoil depth and soil biological activity.

For example, if you were to grow relatively shallow-rooted corn one year, the next year you might grow fodder beets that will go several feet deep, using their huge system of roots to bring potassium and phosphorus up near to the surface. When you harvest the massive, 15-pound beet, it is only the top of an inverted conical pyramid of roots that fan out to probably more than three feet in diameter at the soil surface, tapering to a point five feet down. The part we harvest is less than half the weight of this entire root system. Fungi and earthworms can feed on the many pounds of smaller roots left behind throughout the soil, freeing the phosphorus and potassium for the next crop.

With rotation of crops grown for energy, today's corn farmers will begin to ask themselves, "Why not grow 800- to 1000-gallon-per-acre crops like fodder beets, Jerusalem artichokes, or sweet sorghum—and still be able to grow a cover crop like fava beans over the winter, to be turned in, providing fertilizer and organic matter to grow the next crop?" Why not, when it not only is productive and profitable, but gives us a cleaner environment and healthy soil? When farmers realize their co-op can gross $2300 per acre just on the alcohol, and can also demolish almost all chemical input costs by returning (for example) the spent beet pulp, or the manure from animals eating the beet pulp, into the soil—it becomes difficult to consider a reason *not* to do it.

POLYCULTURE, PHOTOSYNTHESIS, AND PHOTOSATURATION

Polyculture is an advanced method of agriculture that obtains the multiple benefits of crop rotation by growing many crops simultaneously. Polyculture dramatically increases the productivity of photosynthesis by eliminating **photosaturation**, or solar saturation, the point at which a plant's photosynthetic machinery is shut down by excess sunlight.

Simply put, photosynthesis is carbon dioxide (CO_2) plus water (H_2O) plus sunlight (energy for the reaction), which creates six molecules of CH_2O **(glucose)** plus a molecule of oxygen (O_2). Glucose is the basis of starch and cellulose.

A wide cross-section of the plant world photosaturates at 30% of a day's total sunlight, at which point more sunlight will not increase photosynthesis. This means that most plants grown in full sunlight stop growing in the middle of the day due to photosaturation, and don't resume growing again until the afternoon. And even if they can take the solar stress, they "waste" two-thirds of the surplus sunlight falling on them. Why? Because if a plant species needs unobstructed full sunlight all day, and then some tree extends a branch and shades it, the species will go extinct.

But plants that have evolved to use a fraction of the available sunlight have also evolved to

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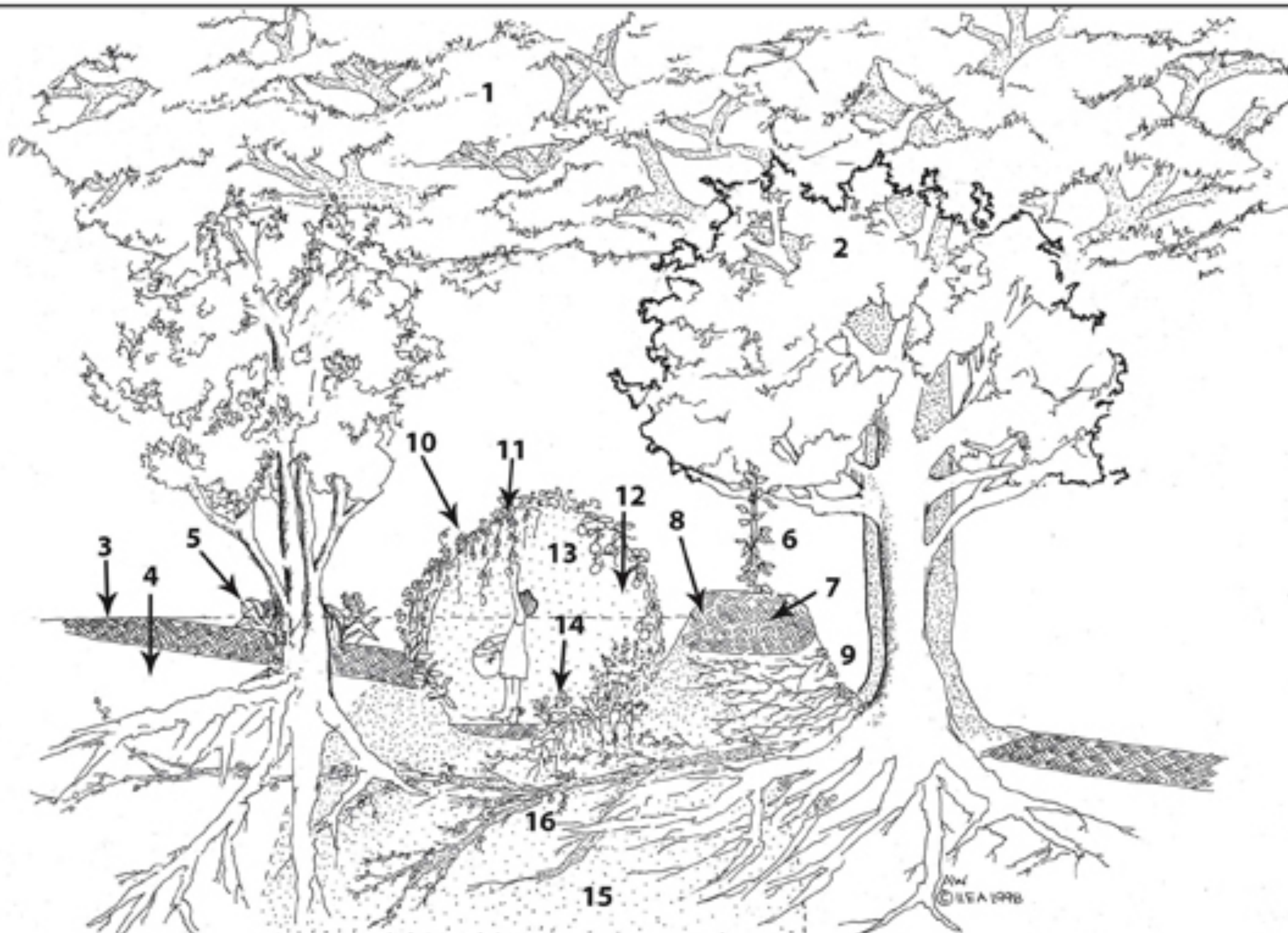
RIGHT: Fig. 3-2 Photosaturation. *Winter squash visibly demonstrate their saturation by excess sunlight. This well-irrigated plant is "wilting" at two p.m. in mid-September at a cool 60°F; in this way the plant deflects most of the direct sunlight. Note how much self-formed shade the leaf has created.*

By the time the system has been operating for three years, there's enough water stored there to irrigate the trees lining the swale for 100 years, even if it never rains again.... One acre of integrated production like this would financially outperform 2000 acres of corn.



DESIGNED BY DAVID BLUME, ILLUSTRATED BY ALINDA WORLEY

Fig. 3-5 Permaculture production system. *In order to make the most out of scarce rainfall, this permaculture design uses a* **swale** *(a dead-level ditch, the interior area between the grade behind and the berm in front) to collect water as its primary feature. Although this particular design is focused on food and flower production, it could easily be altered slightly to focus on energy crops. Bear in mind this is a fairly simple design; it could be much more dense, yielding even more crops and profit. Starting from the top is* ***(1)*** *a wide-canopied,* **nitrogen-fixing**, **Farmer's tree** *that provides light shade and bee forage. Understory trees* ***(2)*** *provide food or energy crops. Topsoil* ***(3)*** *is shown cross-hatched; subsoil* ***(4)*** *is shown white. Bulbs* ***(5)*** *are planted around bases of trees, generating a high-value flower crop while protecting trunk and roots from burrowing animals. Flowers or surface-harvested crops like nopales can be planted from the trunk out to the drip line. Drip line crops* ***(6)*** *such as trellised berries exploit the surplus moisture of this zone and are often planted on the well-drained part* ***(7)*** *of the swale berm* ***(8)***. *Berm faces can be planted in deep-rooted permanent crops such as strawberries* ***(9)***, *which root to six feet. Although shown here on only one face, such crops can be grown on all three faces of the swale (on the uphill side of the swale and the inside and outside faces of the berm). Over the swale, a trellis* ***(10)*** *increases cropping area. Beans or berries* ***(11)*** *or squash/cucumbers/melons/tomatoes* ***(12)*** *make good use of the trellis and provide shade (***13***). The shaded bottom of the swale has rich soil for high-value vegetable crops or even energy crops such as fodder beets* ***(14)***. *The swale bottom, with its air stabilized by the trellis crops, would also benefit from heavier-than-air carbon dioxide enrichment and irrigation with* **stillage**. *The shaded subsoil* ***(15)*** *is permanently hydrated by the water soaking in from rain. By the time the system has been operating for three years, there's enough water stored there to irrigate the trees lining the swale for 100 years, even if it never rains again. Nitrogen-fixing bacteria* ***(16)*** *on the roots of the Farmer's tree provide all the nitrate fertilizer needed by all the crops grown under its* **canopy**. *Mycorrhizal fungi in the top few feet of soil knit all the plants together, sharing the nutrients extracted from the soil and the carbohydrates provided by the upper canopies. One acre of integrated production like this would financially outperform 2000 acres of corn.*