CHAPTER 12

MICRO-DISTILLERY MODEL FARM

One afternoon, I sat down with my calculator and turned on the permaculture designer part of my mind. What might a farm produce with a micro alcohol fuel plant as its central component? Bear in mind, this is only a snapshot of a simple idea of integrating some of the co-products into a production system. It is not a fixed recipe, and you could find endless variations, based on the markets and climate of your area.

In permaculture, we have a tradition of failing small and often to learn lessons we can apply on the larger scale, so I am starting this experimental design on a very small scale. To be very conservative,

BEAR IN MIND, THIS IS ONLY A SNAPSHOT OF A SIMPLE IDEA OF INTEGRATING SOME OF THE CO-PRODUCTS INTO A PRODUCTION SYSTEM. IT IS NOT A FIXED RECIPE, AND YOU COULD FIND ENDLESS VARIATIONS, BASED ON THE MARKETS AND CLIMATE OF YOUR AREA. I'LL USE FISH, MUSHROOMS, AND WORMS AS AN EXAMPLE.

ARCHER DANIELS MIDLAND

Fig. 12-1 Greenhouse cucumbers, grown under optimal conditions of elevated carbon dioxide and warm temperatures. *Archer Daniels Midland can produce three times the yield per square foot of outdoor farms year round.*

it is based on a micro-plant operating on purchased grain (at least initially) and running off a batch every four days. To make calculating easy, I am assuming it will process 1.15 tons of corn and will produce 100 gallons of alcohol per batch.

We are not using the stalks (corn stover) for cellulosic alcohol production in this scenario, but are instead discing them back into the ground to improve fertility. We will use a small fraction of the stover, about 11 tons, in mushroom cultivation.

Initially, this setup will produce a little more than 9000 gallons of 196- to 200-proof alcohol per year—enough to fuel a mini community-supported energy (CSE) co-op of about 18 vehicles traveling 10,000 miles a year at 20 mpg.

In this micro-model, the distillery also serves as a cooker and fermenter, which simplifies the equipment needs. We will also be using an external heat exchanger and a straw-bale-insulated hot water storage tank as part of the scheme. The flue of the distillery/cooker will have a heat exchanger in it to capture waste heat to be stored as hot water. The condenser will use a heat pump both to chill the alcohol and recapture that heat for a little more hot water. The same heat pump will be used to control the distillery column. The electricity will come from an on-site cogenerator that also heats water. If the plant owner drives a hybrid, this system will allow him to convert to plug-in hybrid electric, using surplus electricity from the alcohol-powered generator.

Process heat energy initially will come from waste wood products, such as orchard prunings and broken pallets, but eventually will come from a coppiced woodlot planted to produce firewood. We'll burn the wood waste or firewood in a cob rocket stove to keep the skill level and welding to a minimum. I'll briefly mention how an optional methane digester might be worked into this model, as well.

The distillery model is based on an eight-inch-diameter column, producing 180- to 190-proof alcohol at 16 gallons per hour. The alcohol could simultaneously be dried to 196–200 proof in a pressure swing corn grit water extraction system for dehydration of the alcohol. Although it's not strictly necessary to dry the alcohol to this level, the energy efficiency of this two-step approach is significant.

So there are some things we can observe right away. We will operate the still about 91 times a year, so we'll buy or grow 105 tons (91 × 1.15 tons per batch, or 3750 bushels) of grain per year to operate the plant. Assuming a yield of 160 bushels per acre, that means we are looking at approximately 23 acres of corn. Over time, this acreage will go down, and the yield will go up, as we apply what we learned from the experiments in Chapter 3.

Initially, this setup will produce a little more than 9000 gallons of 196- to 200-proof alcohol per year—enough to fuel a mini community-supported energy (CSE) co-op of about 18 vehicles traveling 10,000 miles a year at 20 mpg. We will sell the alcohol at $2.50 per gallon to CSE members and pass the federal tax **VEETC (Volumetric Ethanol Excise Tax Credit)** of 51 cents per gallon on to the drivers. The driver's net cost will then be $1.99 per gallon plus sales and road taxes. We'll keep the producer's tax credit of ten cents per gallon.

This plant will produce about 33 tons dry weight of wet distiller's grains (WDG), and another three tons of nutrients in the thin stillage, a.k.a. distiller's solubles (DS). Although it's possible to use solar energy to dry the WDG to distiller's dried grains (DDG) for storage, here we are using the WDG as it's produced. Unlike large alcohol plants, we will not be evaporating the water and condensing the solubles to be mixed with DDG.

The plant will also produce 50 tons of carbon dioxide, which we plan to use entirely on the farm. If we could find a local market, the CO_2 might sell for greenhouse use at $5000–$8000.

From the permaculture vantage point, making alcohol and then selling the feed and CO_2 would be letting most of the valuable resources leave the property, without extracting all the various yields from these surpluses. If we simply sold the 33 tons of DDG wet as feed to a local dairy, we might get only $1500 for it.

Our use of the DS is a key factor in how we proceed to co-product development. For this scenario, I have chosen to integrate the DS in both mushroom and fish-raising components. At a minimum, we could use the grain products in our own livestock operation. We could choose, for example, to convert WDG at a dry feed/product ratio of 10:1 in beef, a 3:1 ratio in chicken, 1.6:1 in fish, or close to 1:1 for shrimp or earthworms.

I'll use fish, mushrooms, and worms in this example. Even though I am using wet distiller's grains, I give you what the dry weight of those grains would be in order to let you compare apples to apples.

Let's divide our annual production of 33 tons dry weight of WDG into three 11-ton parts. The first third of the WDG will directly become fish food. At least half of the food that tilapia eat can be WDG. The other half must include expensive lysine and methionine amino acid feeds to balance the amino acids in WDG—or we can figure out how to produce the needed amino acids on our farm. As you'll see in a minute, a byproduct of what we do with the second 11-ton portion of DDG will take care of our fish needs nicely.

The second 11 tons of the WDG will be used for oyster and/or shiitake mushroom production. The first step will be to take the WDG immediately from the distillery tank at the end of distillation when it is boiling hot and fully sterile. We will separate the granular WDG from the liquid DS in a modified washing machine (modified by changing pulley sizes on the motor and washing drum) on spin cycle. At 250 pounds per run (90 runs per year), using three mesh bags per spin cycle, this would require six five- to ten-minute batches. This process dewaters the WDG and leaves us with separate hot DS.

We will use some of these 900 gallons of boiling-hot DS to pasteurize and enrich shredded dry corn stover with the soluble nutrients. We will use about the same dry weight of stover as the dry weight of the second third of the WDG (11 tons) or, to put it in terms of a single batch, a little less than 500 pounds of combined stover and WDG. That's about three three-string bales or ten two-string bales. The stover is needed to provide good aeration for the mushrooms' growth. We'll add some lime to balance pH. Remember, we have removed most of the carbohydrates from the grain already by fermentation. The carbohydrates that the mushrooms will eat will be mostly the cellulose in the stover and the small amount of cellulose in the WDG. Protein, fats, and minerals are provided by the WDG and the DS.

> *"If the world were merely seductive, that would be easy. If it were merely challenging, that would be no problem. But I arise in the morning torn between a desire to improve the world, and a desire to enjoy the world. This makes it hard to plan the day."*
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> —E.B. WHITE, AUTHOR

Mushroom-growing takes two small buildings, which can be made from ocean shipping containers or, better yet, straw-bale construction plastered with lime. The first building is a clean room (where all the air has been filtered to remove

Fig. 12-2

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