The TimberFish Ecotechnology

Summary

The TimberFish Ecotechnology represents a new form of sustainable agriculture that can resolve many of the problems created by climate change, environmental pollution, and rising human populations. The technology is ideally suited to recycle non toxic food wastes from a host such as a food processor, restaurant, or dining hall and to use them to produce seafood that could be used for future consumption at the restaurant or dining hall. This proposal describes a mobile demonstration system that could be located at a potential host's site that would allow for an evaluation and application of this technology.

Introduction

TimberFish creates a new food chain that is not dependent on existing agricultural or marine resources. Clean waste streams from restaurants and the food and beverage industries can be combined with a wide variety of non agricultural plant materials such as wood chips that can be sustainably harvested from diversified ecosystems such as forests. This combination is used to grow microbes, which are fed to invertebrates, which are fed to fish and shrimp. The resulting seafood is contaminant free and locally produced. The only other outputs are clean water, a high energy clean residual wood chip, and potting soil. The process is non-polluting, ecologically sustainable, and economically competitive in todays' market.

TimberFish has an operating commercial pilot system using this technology at the Five & 20 Spirits & Brewing facility in Westfield, New York. This facility receives all of the byproducts and production waste streams (no sanitary wastes) from the distillery and its companion brewery. The system grows fish and freshwater shrimp, recycles and treats all solid and dissolved wastes, produces a high energy wood chip residual comprising a renewable biofuel, and discharges a high quality effluent under permits issued by the New York State Department of Environmental Conservation.

Modern agriculture is based on the monoculture production of fruits, grains, and vegetables. It is dependent on cultivation, commercial fertilizers, and pesticides, and as such contributes significantly to nutrient and chemical pollution of the environment and the destabilization of the global ecosystem. TimberFish avoids these problems by creating a new food chain based on recycling food and food processing wastes and the selective sustainable harvesting of natural ecosystems such as forests and woodlots which are located on non agricultural land. The technology preserves the biodiversity, aesthetics, and biodynamical stability of these ecosystems without the use of cultivation or pesticides. It provides a renewable energy source, promotes reforestation and deforestation avoidance, and does not pollute ground and surface waters.

The Demonstration System

TimberFish has a small demonstration system (the Demo) that can illustrate this technology and which can be temporarily installed and operated for evaluation by an interested party (the Host). The Demo is trailer mounted with its own set of electronic controls and can be operated remotely by TimberFish personnel. It can be located anywhere that electrical power is available, or it can run with its own generator. Connections to water and sewers are preferred but are not absolutely necessary as the system can operate as a zero discharge system for a brief demonstration period.

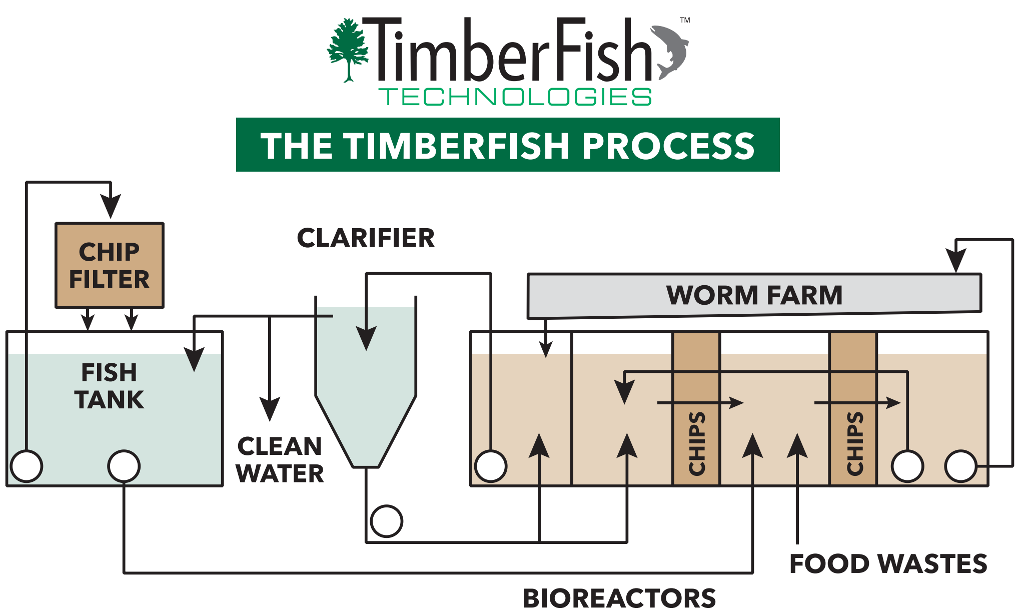
This system requires no inputs other than a clean non toxic food waste stream and wood chips sustainable harvested from nearby forests and woodlots. It discharges a tertiary treatment quality effluent that can be land applied or discharged to a sewer or receiving water under strict permit regulations. Partially degraded wood chips constitute a high energy residual that can be used to generate heat, electricity, or biofuels. The only other output product of the process is a potting soil type material.

Because this is a modular technology it can be implemented gradually and carefully studied and researched prior to any potential full implementation. This is a portable system that is trailer mounted and therefore can be easily removed if desired. It contains all required process control and monitoring equipment and can be remotely monitored.

The system itself is housed in a series of tanks, each being about 6 feet wide and 3 feet tall. It comprises several microbial growth bioreactors, a worm farm, a fish raising system, and an effluent treatment system that is derived from current activated sludge advanced wastewater treatment technology. The system contains a number of pumps, an aeration system, wood chip baskets, and a variety of piping and electrical components.

The system functions via a series of continually or periodically operating recycle flows. It can accept a periodic input of food wastes from a Host and discharges a tertiary treatment quality effluent. The system operates with a long hydraulic detention time of 100 days or more. While having a location on a small farm associated with the Host or a sewer connection is preferable the Demo can use periodic land application or truck its final effluent wastewater to a nearby municipal wastewater treatment plant. All of these options will be dependent on local and state regulations and permitting requirements. However, the extremely high quality of the effluent should make this a very manageable issue.

The following drawing presents a diagram of this demonstration system.



The system functions as follows:

Bioreactor #1 Comprises five zones in the right hand side of a 1,000 gallon tank. This Bioreactor can receive small quantities of food wastes on a daily basis from the Host. The bioreactor contains two netted chip basket zones and three water zones. A recycle pump maintains a continuous recycle flow and the bioreactor is vigorously aerated so that oxygen is continuously available to a large and diversified microbial population that is resident in the water and attached to the surfaces of the food wastes and wood chips. This promotes rapid microbial growth and consumption of the food wastes.

As the microbial population increases a small fraction of the microbe rich water is periodically pumped into a **Worm Farm**. This Worm Farm comprises two or more shallow trays that contain a layer of wood chips. When the microbe rich effluent from Bioreactor #1 is pumped into the Worm Farm it flows through the trays and gradually seeps out of the Worm Farm. This action filters the stream thereby removing the suspended microbes which then become attached to the wood chips or settle around them making a soil like mixture. Worms living in the farm then eat the microbes and excrete worm castings which add to the soil like quality of the Worm Farm.

The effluent from the Worm Farm flows into the **Bioreactor #2** (on the left hand side of the bioreactor tank). There additional aeration supports the growth of more microbes that degrade any non digested substrates from the worm farm. This biomass is then transferred to a clarifier in which floating or settling microbial solids are recycled back to Bioreactor #1. The clean water effluent from the clarifier is either discharged from the system as a final effluent or sent to the **Fish Tank**.

The Fish Tank is where the fish are grown. It is an aerated circular tank which has a basket containing wood chips perched directly above, but not touching, the water surface. A pump continuously pumps water to the top of the chip basket and this water then seeps down through the wood chips. Microbes living on the surfaces of the irrigated wood chips remove any soluble nutrients such as ammonia and phosphate from the fish wastes in the water.

A side stream from this pump is also directed into the tank itself in such a manner that it establishes a circular flow of water around the tank. This circular flow causes the solid fish wastes to be concentrated in the center of the fish tank. There a second pump periodically pumps these solids back into Bioreactor #1.

Periodically some worms are removed from the Worm Farm, separated from the chips and worm castings, and then fed to the fish. Once the concentration of worm castings in an area of the Worm Farm becomes too high the solids are removed from that area of the farm. The worms are harvested and the residual material separated into castings and wood chips. The castings can become a valuable potting soil and the chips can either be returned to the worm farm, returned to other chip zones in the system, or washed and used as a fuel source. Spent wood chips from the other baskets will also be similarly treated once 50 percent of their dry weight has been degraded by the microbes.

Depending on the rates of microbe, worm, and fish production a low protein fish pellet may be used as needed to supplement the fish feed to maintain good fish growth. Such a pellet will not contain any fish meal or fish oil and hence will avoid any potential contamination from those sources.

A full application of this system would only use microbial populations and worms and other invertebrates that are currently living in the local ecosystem. Fish would need to be obtained from a local or regional permitted fish hatchery and we will only grow fish that are native to, or well established in, the local area.

The entire demonstration unit is skid mounted on a 34 foot long goose necked trailer with a 28 foot bed. The system includes blowers, pumps, sensors, level controls, an electrical panel, process control instrumentation, phase converter if necessary, and internet connectivity. The trailer deck is 30 inches above ground level. It has sides that fold up for transporting and which can be lowered to provide decking around the system so that people can walk around and easily see all the components and moving parts. There are detachable railings to maintain safety on the deck. The system runs on three phase power so that we can operate variable speed pumps and blowers to provide adequate aeration, etc. It includes a phase converter to change a 220 v, 50 amp feed line to the appropriate three phase system. We can also run this system with a portable generator if necessary.

The trailer could be located inside or outside depending on what was available. If a potential Host wanted to keep the system it would probably be best if it were located inside. Alternatively, a small green house structure could be built to house the system. The system could take up to 20 to 30 gallons per day of brewery and/or restaurant waste and would then discharge 20 to 30 gallons of clean water back to the sewer, farm, or a holding tank for eventual land application or trucking to the wastewater treatment plant. The input loading would be dependent on the nitrogen and phosphorus content of the food waste.

The demo could produce 100 pounds of fish per year, more if additional tanks were added. This would depend on the strength and nutrient concentrations of the food wastes. For steady state operation the choice of fish species would depend on whether or not to heat or cool the fish tank. Catfish can tolerate both cold and warm water but grow best at about 76 F. Trout would do fine at 55 to 60 F but would die off above 70 F. If shrimp would be desirable then water temperatures need to be around 78 F. They don't do well under 70 and die by the time you get close to 60.

Implications for a Potential Host

Because the TimberFish system is modular it could be initially installed on a very small basis for evaluation. If a potential Host decided to proceed with the program the trailer could become part of a permanent installation that could then gradually be expanded over time. It could then be integrated into a comprehensive Environmental Action Plan. A medium to large scale application of the TimberFish technology could allow a Host to exceed a goal of achieving carbon neutrality.

To illustrate how the TimberFish system impacts carbon calculations the attached three Figures show how TimberFish changes the carbon footprint and climate impact of our current food production technology.

Figure 1 illustrates where most of our food comes from and how it is produced. Fruits, vegetables, and grains are grown on farms and either used directly as food or are processed into a variety of food products. Similarly, seafood is either wild caught or farm raised and consumed directly or processed into various food products. In addition a lot of grain is produced for animal feed and this generates meat, eggs, and dairy products such as milk which again can be consumed directly or used in the production of other food products. Some grain is also used as feed or feed ingredients for fish farms.

Figure 1 Current Food Production

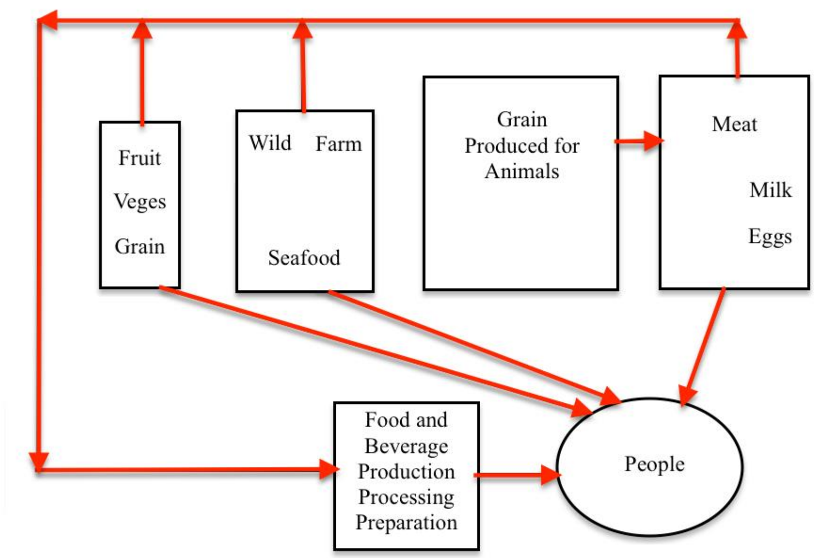


Figure 2. shows the waste streams that are generated by this current food production technology. Farms producing fruits, vegetables, and grains often have storm related agricultural runoff that contains nutrients, sediments, and pesticides. Seafood and terrestrial animal farms will discharge wastewater, washwater, and solid wastes such as manure. Food production and processing facilities will also have wastewaters and solid waste streams as will restaurants and food distributors. Food preparation and consumption in family households will generate food related wastes that are usually disposed of as garbage or composted.

Figure 2 Current Food Production Waste Streams

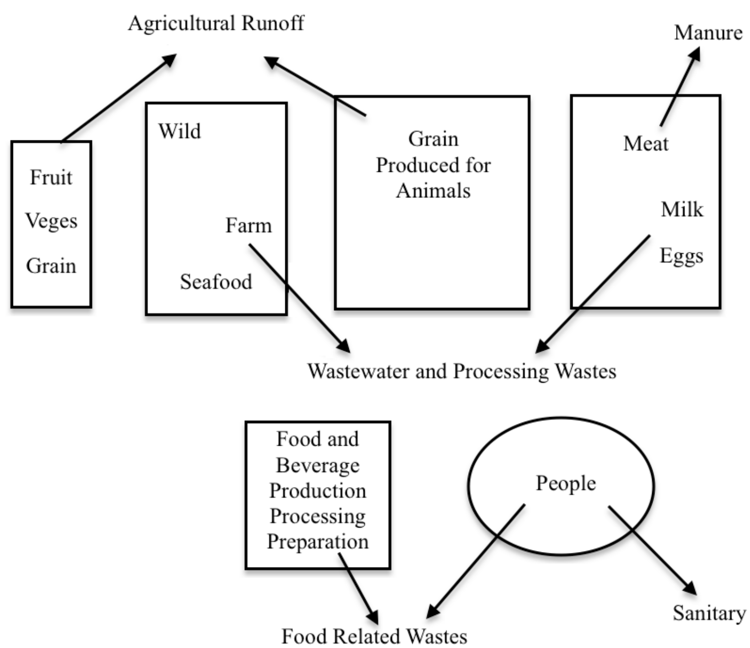
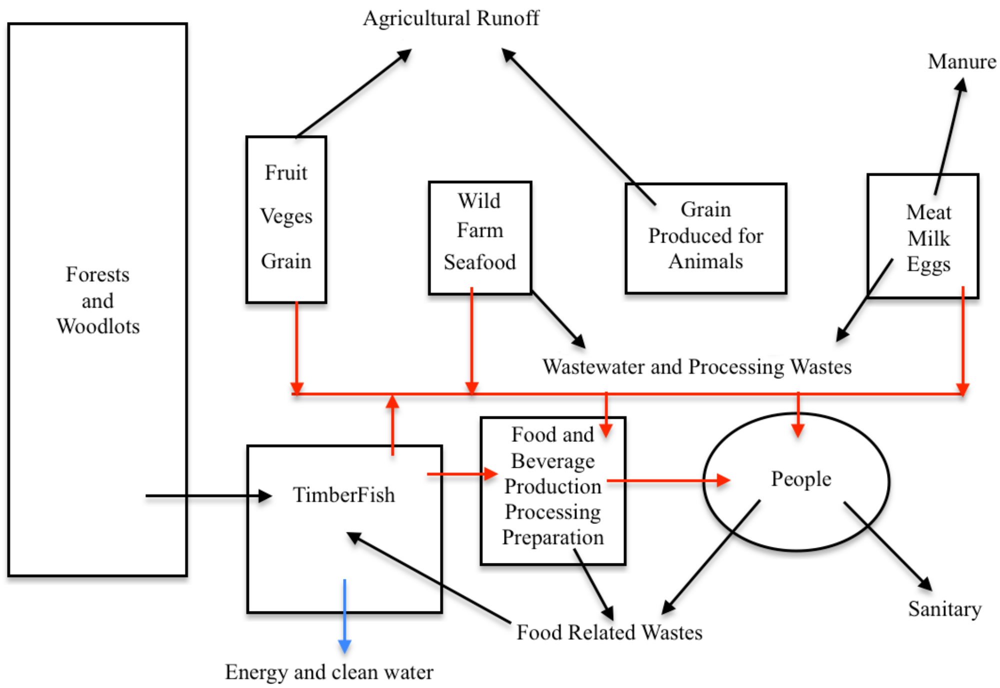


Figure 3 shows how the TimberFish Agricultural Ecotechnology can integrate with modern agriculture and our current food systems. It incorporates forested land currently unused for agriculture and recycles the wastes currently generated by the production, processing and preparation of food. It also incorporates uneaten food and food wastes from restaurants and family households that arises from the acts of actually locally preparing and eating the food. Agricultural runoff, manure and sanitary wastes are not included in this ecotechnology but the wastewater and animal processing wastes from the animal growing and byproduct (eggs, milk) facilities could be included in the TimberFish system.

Figure 3 TimberFish Agricultural Ecotechnology



As an example of how this might work, look at the hypothetical operation of a potential Host comprising a restaurant or one or more dining halls, and consider the difference between serving 1,000 pounds of spare ribs obtained from current commercial sources with 1,000 pounds of catfish produced by the onsite TimberFish system.

The spare ribs would come from hogs grown in a hog barn with a ventilation system. It stinks. The manure from the hogs goes to an anaerobic lagoon for winter storage. There it emits greenhouse gases such as methane, ammonia, hydrogen sulfide, and a variety of volatile organic compounds. It also stinks. The manure in the lagoon is then land applied to cornfields in the warm weather, and this really stinks. It also emits some greenhouse gases. In particular the majority of the nitrogen in the liquid manure is ammonia. Most of this goes to atmosphere in the first three days it is on the land. The resulting imbalance in the nitrogen to phosphorus ratio in the soil then contributes to phosphorous accumulating in the soil and running off into surface waters during rainstorms.

Now look at the cornfield. It is a monoculture and hence environmentally unstable. It is maintained by the use of cultivation and pesticides. There is no biodiversity. There also is minimal carbon sequestered in a cornfield.

Contrast this situation with the 1,000 pounds of catfish. First of all there are arguments that catfish are better for you than ribs, omega threes and all that, but leaving that aside. The fish are grown in an aerated system in a barn. This does not stink. The only greenhouse gas emitted is carbon dioxide and that is recycled into the forests for future woodchips for future fish production. The fish manure is recycled back through the TimberFish system and the nitrogen and phosphorus is recaptured by more microbial growth, eventually leading to more invertebrates and more fish.

Forests and wood lots are very different from cornfields. There is a lot of biodiversity and natural habitat. Pesticides and cultivation are not needed. Stormwater runoff from forests does not contain the sediments and nutrients that are found in agricultural runoff. They are aesthetic and natural ecological places. They also sequester a lot more carbon, both above and below ground, than does a cornfield.

Now look at the food waste that is produced by the Host from the 1,000 pounds of ribs or fish. Where does it go now, landfill? Perhaps composting? In a TimberFish application it would all go back into the system as a source of nutrients, such as nitrogen and phosphorus, and energy to drive the synthesis of microbes which feed more invertebrates which feed more fish.

When all of these factors are considered in a sustainability carbon footprint analysis the TimberFish application will represent a major improvement over conventional wastewater treatment options for a restaurant or dining hall type of Host. The monetary savings to the Host could be significant. The public environmental and sustainability features of the system could also be used to promote and publicize the Host.