The TimberFish Sustainability Proposal for Universities

Summary

This proposal describes an educational sustainability program modeled on a principle of participatory ecotechnology. It is multidisciplinary, hands on, and integrally related to the real world. The program offers many benefits for students by demonstrating the meaning of sustainability in local and entrepreneurial applications. It also will integrate the knowledge they obtain in the academic areas of the natural sciences (biology chemistry, physics), applied technology (engineering, computer science, fabrication, construction), business (economics, entrepreneurial startups, marketing), mathematics, sociology, philosophy, and art.

The program demonstrates an ecotechnology that is unique, practical, and scalable to global application. Thus it will be attractive to students who are very concerned about the looming issue of Climate Change, and who don't know what they can do about it. The program illustrates the principles of ecotechnology in terms of applications developed by TimberFish Technologies. This technology is described by five issued US patents which TimberFish uses to protect its business only in large scale applications in the US. Small scale applications in the US, and all international applications, are free of charge. Specifically, TimberFish will issue a site license to a university for their use in any and all university educational and research activities and applications. These can include university promotional and fund raising events and initiatives, research grant applications and programs, and student entrepreneurial and technology transfer activities.

The university program is centered on student participation in the building and operation of ecotechnology systems that can produce seafood from local sustainably harvested forests and woodlots. This can incentivize reforestation and deforestation avoidance, which will help mitigate Climate Change. The proposed program comprises table top units of 10 to 100 gallons which can be expanded to lab units of up to 1,000 gallons or more.

This could then lead to large scale production units capable of producing significant quantities of fish and other seafood.

As part of the proposed program TimberFish could deliver a mobile demonstration system (the Demo) to the university. The Demo is a trailer mounted unit with its own set of electronic controls and can be maintained and operated by students, faculty or staff. It also could be remotely operated and/or monitored 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 or land application system for a short demonstration period. Appropriate permits for the demo will be obtained from NYS DEC for any form of the demonstration.

TimberFish has operated a commercial pilot system at the Five & 20 Spirits & Brewing facility in Westfield, New York that illustrates what a scale up of this system might look like. This facility received all of the byproducts and production waste streams (no sanitary wastes) from the distillery and its companion brewery. The system grew fish and freshwater shrimp, recycled and treated all solid and dissolved wastes, produced a high energy wood chip residual which could be a renewable biofuel, and discharged a high quality effluent under strict permits issued by the New York State Department of Environmental Conservation.

This program has an additional benefit in that it provides a template for the revival and continuation of the "Global Village" concept that Marshall McLuhan introduced in the 1960s. This could now include a series of local sustainable green circular economies which would integrate sociological, economic, and environmental factors into a sustainable future for humanity. It presents a potential path to resolve the issues of global Climate Change and environmental pollution.

Additional information about TimberFish can be found in the following video,

https://vimeo.com/254851511

And on our website,

www.timberfishtech.com

The Process

TimberFish creates a new food chain that is not dependent on existing agricultural or marine resources. Clean waste streams from restaurants, recirculating aquaculture systems, 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.

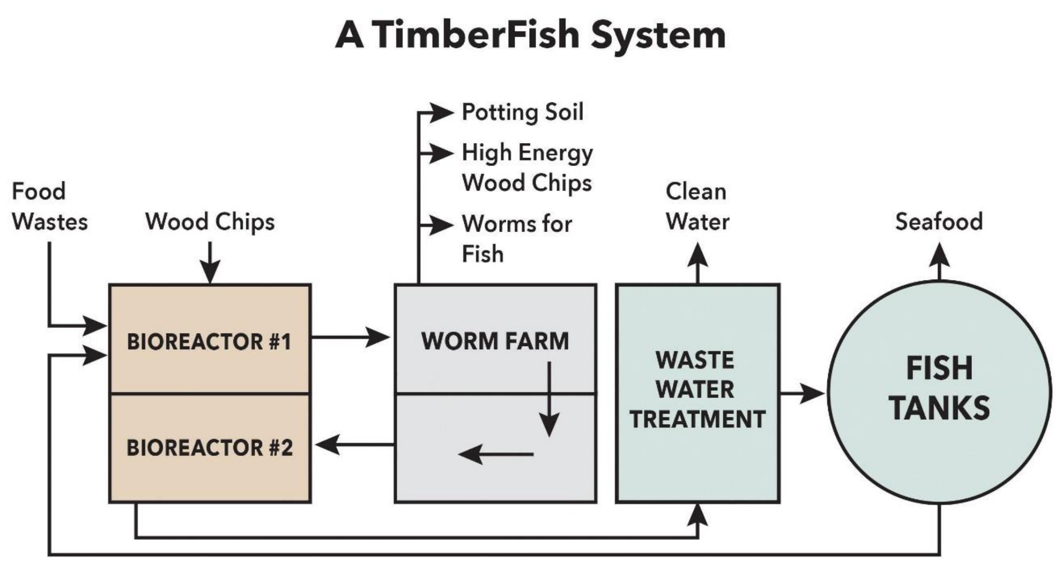
The TimberFish Technology (TFT) combines elements from Recirculating Aquaculture Systems, Integrated Multi-Trophic Aquaculture, and Biological Municipal Wastewater Treatment. The resulting technology was implemented in a complex and diversified ecosystem production facility that raised fish and other seafood utilizing plant material harvested from non-agricultural land and production residuals from the food and beverage industries as sole material inputs.

The TFT mimics the natural food-chain of fish and macro-invertebrates. It combines water purification and underutilized biomass to produce salable seafood, clean water, soil amendments, and biofuels. The process is local, sustainable, environmentally friendly, removes solid and soluble pollutants from water; creates contaminant-free seafood; is not dependent on chemical use; and generates a high energy residual wood chip that can be used for heating, generation of electricity, or the production of biofuels. TFT is economically attractive, providing a commercial driver for the global proliferation of environmental best practices including reforestation and deforestation avoidance.

The process comprises a series of interconnected internal recycle flows and sub environments that contain a large variety of organisms ranging from microbes, to invertebrates, and fish. It works by combining plant material with nutrients contained in by-product waste streams. The microbes are grown in this mixture and then become food for the invertebrates that are also resident within the system. The structure of the system is such that it is easy to provide these invertebrates to the product fish or other seafood that also reside within the system for their consumption.

The TFT system is designed to contain an extremely large variety of microorganisms and many different species of invertebrates. All of these can reside in various physical sub environments ranging from suspended floc structures and single cell aggregates to fixed film layers that will reside on the matrices comprising wood chips, grain hulls, and other grain and fruit non fermented residues.

A general schematic of the process is as follows.



In this application Food Waste can comprise any non toxic waste, wastewater, or byproducts from food production and processing facilities, as well as such wastes from restaurants or cafeterias.

The Demonstration System

TimberFish has a small demonstration system (the Demo) that can illustrate this technology and which can be temporarily or permanently installed and operated for educational and research purposes at the university. The Demo is trailer mounted with its own set of electronic controls and can be operated remotely by TimberFish personnel. It also can be detached from the trailer and 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 nutrient 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.

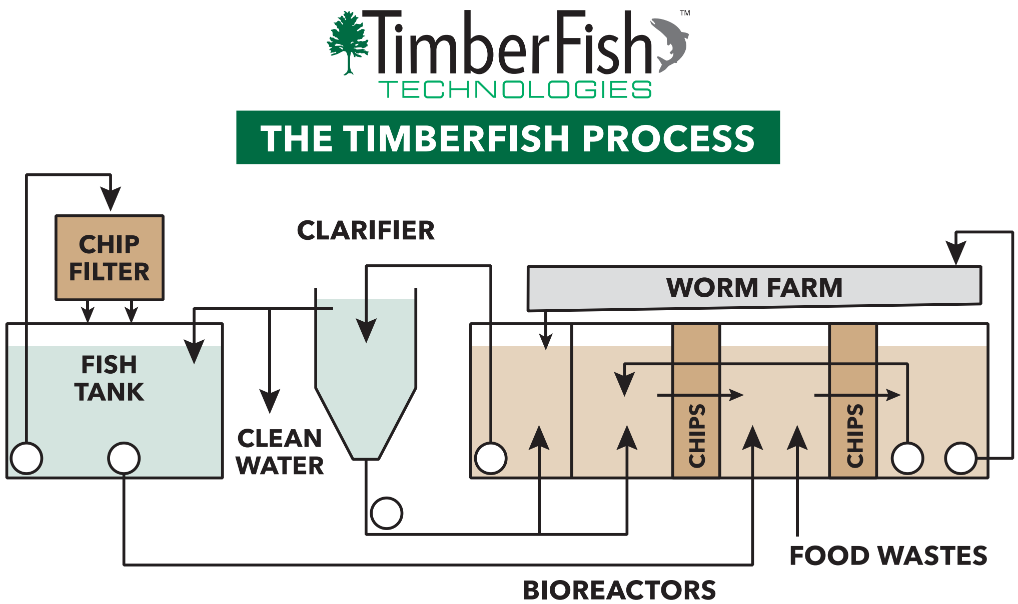
The non toxic nutrient inputs to the system could be from a low protein commercial fish feed pellet that would be fed to the fish in the fish tank, or it could be from a food or food processing waste. In either case the aquaculture waste from the fish tank would be recycled back to the bioreactors.

Because this is a modular technology it can be implemented gradually and carefully studied and researched prior to any larger scale research or technology transfer applications. Since this is a portable system that is trailer mounted it can be easily removed if desired. It contains all required process control and monitoring equipment and can be remotely monitored.

The Demo 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 nutrients, such as food or aquaculture wastes, and discharges a tertiary treatment quality effluent. The system can operate with a long hydraulic detention time of 100 days or more. While having a location on a small farm associated with the university 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 will receive the aquaculture wastes from the fish tank, and can receive small quantities of food or other nutrient waste from if desired. 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 and aquaculture wastes and wood chips. This promotes rapid microbial growth and consumption of the 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 from the system 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. This would not impact the ability of the system to receive and process food wastes.

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, a given local area.

The entire demonstration unit is skid mounted on a 34 foot long goose necked trailer with a 28 foot bed. Here is a photo of the demo system.

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 system, with or without the trailer, could be located inside or outside depending on what was available. If the university 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.

The Demo can be scaled up to a production level. TimberFish has operated a commercial pilot system at the Five & 20 Spirits & Brewing facility in Westfield, New York that would illustrate what this scale up might look like. This facility received all of the byproducts and production waste streams (no sanitary wastes) from the distillery and its companion brewery. The system grew fish and freshwater shrimp, recycled and treated all solid and dissolved wastes, produced a high energy wood chip residual which could be a renewable biofuel, and discharged a high quality effluent under strict permits issued by the New York State Department of Environmental Conservation.