

Farming Fish without Feed

By Gunter Pauli

This article introduces a creative approach to fish farming as one of the 100 innovations that shape "The Blue Economy". This article is part of a broad effort to stimulate entrepreneurship, competitiveness and employment.

The Market

The world market for farmed fish and aquatic edible plants was valued in 2008 at \$106 billion. Over a period of 38 years (1970-2008) the growth of fish farming has maintained a steady 6.6 percent increase according to the United Nations Food and Agriculture Organization. Since 2008 there is more money earned with fish cultured in ponds and tanks, than fish caught from rivers and seas, which is valued at \$94 billion, including a record \$10 billion tons from inland waters. Captured fisheries and aquaculture combined supplied the world with 142 million tons of protein. The value of farmed fish is slightly higher than wild harvest, which by volume represents 46 percent of all fish consumed. There is still a lot of room for improvement in productivity. The annual output per person is 172 tons in Norway which is the highest in the world. China lags behind with 6 tons and only 2 tons in India.

Aquaculture is the fastest growing animal food production sector and one of the few to outpace population growth. There are 220 species of fish and shellfish grown in farms. China is the largest producer in the world accounting for 62 percent of global fish farming in volume and 51 percent in value, mainly focusing on carps. Latin America has the highest average annual growth by 21.1 percent over nearly four decades, with mainly tilapia which originates from Africa. Africa is absent from the scene, even though the Continent is home to approximately 25 percent of the world's biodiversity of fresh water fish. Once leading countries like France, Spain and Japan have shown falling production over the past decade.

Per capita consumption of farmed fish has increased from 1.5 pounds in 1970 to 37 pounds in 2008. Fish accounted for 15.7 percent of the world's population's intake of animal protein, and 6.1 percent of all protein consumed. Employment in the sector has grown substantially with an increase of 3.6 percent per year since 1980. There are an estimated 45 million people directly engaged in fish farming. For each person employed about three jobs are generated in secondary activities, thus bringing the total to 180 million jobs worldwide, an increase of 167 percent compared to 1980. Thus growth in employment as well as output, outpaces the world's population increase.

The Innovation

The growth of fish farming is increasingly hampered by the lack of fresh water. On the other hand, many highly priced species are carnivores requiring fish meal as feed. Whereas soy meal costs \$350 to \$400, fish meal costs consistently above \$1,000. The argument goes that it does not make sense to kill fish to feed fish, one should eat fish directly, contributing to a better food security in the world. Fish penned up together in farms consume massive amounts of feed, defecate and create pollution, rendering life within the ecosystem difficult, while increasing the risk of diseases that can wipe out whole industries as was the case with the White Spot Syndrome Virus (WSSV) that decimated shrimp farming, increased demand for antibiotics, which debilitates the human immune system, thus triggering government regulations. Organic waste from fish farms feeds algae, consumes oxygen leaving the area uninhabitable comparable to fertilizer run-off from agriculture. The old strategy that the solution to pollution is dilution does not work in this instance when the farming is that intense.

Professor George Chan, who spent his career as a sanitary engineer for the United States Environmental Protection Agency, took an early retirement at the age of 59 and went back to his ancestral land in China to study rural livelihoods while restoring his ancient family home. The Professor learned how the Chinese farm fish without feeding the fish. Whereas their productivity would be considered low by European and American standards, their efficiency in production of protein from fish, pigs, algae, and plant produce is high, outperforming the productivity of even the Norwegian salmon factories. Whereas experts trained in the core business would measure the output of one mono-cultured fish only, Professor realized that the 7.5 tons of fish per worker is complemented with pork, ducks, rice, cucumbers, algae, biogas and so much more.

Prof. Chan learned how each Chinese piggery (or poultry) farm would carefully collect the manure in a digester. This generates biogas. The slurry flows through algae ponds, further mineralizing the biological matter. This in turn produces algae in a sequence of shallow algae ponds, an excellent feed additive, as well as converting the water into a highly alkaline water that has the ideal nutrient balance to feed benthos, phyto- and zooplankton. The dykes of three meter ponds are covered with grass, which is harvested daily to feed for the grass feeders. The ponds are stocked with minimum seven types of fish, one for each trophic level. The amount of nutrients in the ponds is high, but since the bottom feeders keep the eutrophication to a minimum, and aquaponic farming on floating beds absorbs the rich nutrients that normally a labelled pollution, all the nutrient contribute to increasing the total productivity of the system.

The First Cash Flow

Prof. Chan left China and set out on a mission to develop integrated fish farming. His first project in Fiji, set up as a research facility in cooperation with the University of the South Pacific at the Montfort Boys Town soon became a reference for the whole Pacific Region. The United Nations Development Programme (UNDP) organized a series of technical meetings to share the expertise. The results surprised all the critics since fish production without any purchased feed reaches 15 tons per hectare with a work input of two full time equivalent. In addition, the integrated system raised annually 240 pigs (in units of 60 pigs twice per year). The advantage of this cascading of nutrients and energy is that waste water from both the fish farm and the piggery have been successfully converted into an added value, generating more cash. This cascading of nutrients, matter and energy, generating value added while reducing costs with what is locally available is a typical characteristic of The Blue Economy.

The Opportunity

The hands-on experience from China to Fiji was replicated on all continents. However the broadest interest emerged from Brazil where the pig farmers of the State of Paraná broadly undertook to adapt and replicate the system. The project was adopted by TECPAR, the center for technologies which within a few years time installed nearly 100 production units of integrated fish and pig farming. We have been able to trace over 250 projects in 80+ countries where the work of George Chan has been initiated and or inspired by him, and further developed by local entrepreneurs. All these projects were implemented without even considering the positive effect on climate change. If we add all economic, social and environmental benefits then the integrated farming system outcompetes the single product business model that monocultured fish or dedicated pig farms have pursued in a drive to introduce economies of scale. Now a new farming model imposes itself where thanks to the application of economies of scope, integrating the productivity of the five kingdoms of nature generate more with much less, while creating jobs. That is what the Blue Economy is about.

The Blue Economy GUNTER PAULI

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... Further information on the 100 innovations at www.theblueeconomy.org

For a documentary film on the work of Prof. George Chan by the British producer John Harrison:
<http://www.youtube.com/watch?v=0fFIg5WLn>

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