Bringing more life to the desert

Miles inland, far from the sea or rivers, it is nevertheless possible to create the ideal ecosystem for producing fish and vegetables, which would otherwise struggle to survive in an environment which is not their own. It is through aquaponics, one of the most sustainable and environmentally-friendly forms of agricultural production, that we can combine the two types of production and guarantee food for the future.
In the state of Baja California, Mexico, several clear examples already exist showing the efficiency of aquaponics.

Text: Erick Falcón • Photos: Alex Espinosa

Even in winter, the relentless sun beats down on anyone, locals and visitors alike, who dares venture out over the rough dirt desert tracks of the Guadalupe Valley, just 20 minutes northeast of Ensenada. Out of the car window, you can see mile after mile of vineyards, old signposts indicating the way to Tijuana and a couple of ruined adobe dwellings. As we reach the El Chivatillo ranch, the temperature rises. Sheltering from the heat under the porch of his prefabricated house, the oceanologist Enrique Strasssburger enjoys an iced tea whilst he draws some rough sketches to explain to **Día Siete** how aquaponics – one of the most innovative agricultural production models in the country – works. “For me, aquaponics is the way forward for food production. We use water efficiently to cultivate fish and vegetables in a sustainable manner, and produce higher quality food, since no traditional pesticides are used. And we can do this in cities, which saves on transport costs,” explains the scientist. Along with his wife, partner and fellow oceanologist, Naielli Estuvillo, Strassburger left the rat race behind to come and live in a ranch on the outskirts of the small village of San Antonio de las Minas. Here they founded the Acuicultura del Desierto (Desert Aquaculture) company, which combines aquaculture with protected agriculture and hydroponics to breed tilapia and grow organic vegetables. In an old henhouse converted into a greenhouse, there is a series of polystyrene islands containing hundreds of baby lettuces. A pump and filtration system powered by a solar panel supplies the tilapia tanks in the next room with water. Think pre-Hispanic Xochimilco transported to the 21st century Silicon Valley. Why not? It is not the first time that Mexicans have used intensive agriculture techniques to feed their population; to a certain extent, aquaponics can be seen as the modern, high-tech version of the Aztec *chinampas* (stationary, artificial islands used for growing crops) of ancient Mexico, comments Strassburger.

Aquaponics is taking off in Mexico

It is estimated that this technique allows for a 45% reduction in the use of fertilisers and it yields up to 500 plants per square metre each year

Below: Enrique Strassburger at Acuicultura del Desierto (Desert Aquaculture).
Page 43: The roots are irrigated with water from the tanks in which the tilapia are bred.

Scientists in Ensenada are not the only ones working on this system. Another pioneer in this industry is the Bofish business group, through their subsidiary company Acuaponia, which has been developing the technology for almost three years now in Jalisco. In addition to breeding tilapia and growing vegetables, Bofish-Acuaponia provides technical advice to companies and to private individuals interested in aquaculture, hydroponics and aquaponics. Such is the popularity of the technology that, despite the financial crisis, the company's representatives maintain that two new aquaponic projects may well be launched in 2010. "This system's potential is huge, since you can have both extensive production of fish and plants, and highly efficient water consumption. This is an advantage for states in which water is scarce", declares Héctor Ramos, the engineer in charge of the aquaponic system in the company based in Guadalajara, in the Mexican state of Jalisco. "Acuaponia's productivity has been good: each fortnight it harvests around 1.5 tonnes of tilapia and over 1,400 lettuces including varieties such as Boston, sangria and cos", comments Ramos. Puebla is also interested in developing this industry. This state's Ministry of Rural Development has suggested installing aquaponic systems in 11 municipalities across the following mountain ranges: Noriente, Nega and Mixteca Poblana. According to civil servants from the state office, one of the advantages is the savings offered by these systems, since it is estimated that aquaponic systems reduce the use of fertiliser by 45% and yield up to 500 plants per square metre each year. "Aquaponics not only meets the requirements of intensive farming. These techniques also solve an agricultural enterprise's water and electricity consumption problems", adds Ramos. Through the use of greenhouses, aquaponic farms can be located within a city and offer fresh produce to local consumers. For example, when in season, Strassburger's tilapia are sold in the famous open-air fish market, the Mercado Negro, in Ensenada, where all types of freshly caught fish and shellfish are also on sale. A properly designed system, with alternative energy technology such as solar panels, can have minimal operating costs, although the initial outlay may be considerable. However, its potential constitutes an interesting option for the Mexican agricultural enterprise, assures Strassburger.

"We are going to have to expand and put a number of smaller farms into production, but these will use aquaponic methods, automated processes using wind and sun energy, biodiesel and many other innovations designed to achieve quality and added value rather than simply quantity."

Water efficiency and Sustainability

Because they use greenhouses, the systems can be installed in different climates, and aquaponics therefore has a promising future in facilities where water is scarce, especially in the north of the country. To get an idea of the water savings involved in the use of aquaponic technologies, Héctor Ramos from Bofish maintains that in order to irrigate one hectare of crops in the traditional manner, per season, on average 200 cubic metres of water is needed, which is the equivalent of three quarters of a football stadium filled with water, for an area the size of a block of houses. Aquaponics, on the other hand, uses a third of this quantity, in other words only 70 cubic metres. However, if it is combined with other water recycling and reuse techniques, the system consumes even less water, thanks to other recirculation techniques for intensive farming, such as BioFlock, which uses less than half the amount of water than traditional irrigation systems. "Let's say we have five 80 m3-tanks, which provide a total of 400 m3. Each day 120 m3 of water are consumed to maintain the tilapia breeding system using the BioFlock technique, but with our aquaponic system, we only used 4-6 m3," explains Ramos. The wastewater that drains off from the aquaponic system runs into reserve tanks, which are used to pump water into fields composed of rolls of turf, which saves on fertilisers. Finally, any water that is not used filters into the aquifer and feeds the deep wells on Acuaponia's land, which completes the 100% water reuse cycle. •

Aquaculture + Hydroponics = Aquaponics

In all areas of human experience, promotion of respect for the environment is a growing trend. Therefore, aquaponics is described by its champions as one of the most innovative scientific proposals for achieving the sustainable development of agriculture. However, the basic science of aquaponics does not come from nature, since, by combining the hydroponic and aquacultural techniques of recirculation, sowing and feeding, aquaponic systems attempt to create an artificial symbiotic cycle between the species, resources and technologies, which make up the system. The general idea of aquaponics it to make use of the organic fish effluent, which is processed through a bacteria filter and this then allows the liquid to benefit the plants. This is one of the most sustainable and environmentally-friendly forms of agricultural production. The most commonly bred fish in aquaponic systems are tilapia. Since these fish thrive at temperatures of between 28-31ºC, the controlled climate of the greenhouses complements the optimal environment for the tilapia tanks. Their effluent, which contains ammonium compounds (NH_4), is toxic for fish once it reaches a certain concentration in the water. This is why the waste products are drained and channelled towards biofilters, which contain micro-organisms called nitrifying bacteria, whose natural function converts the toxic ammonium compounds into nitrites and then nitrates, a “magical fertiliser” for plants. “Plants love ammonium nitrate. It has allowed us to grow high-quality basil and lettuces in a small space, using less water and with no pests, in around 15 days, whilst traditional farming methods would take four times longer”, explains Strassburger. The best way of visualising how it works is using the example of a normal fish tank with its

recirculation system. Only that in the case of aquaponics, instead of the water being continuously pumped back into the fish tanks, it is channelled to tanks or biofilters where the nitrification process is carried out, and it is then sent on to the hydroponic beds. Acuaponia circulates the water with nitrates through two 33-metre-long growing tubs, where the vegetables are sown using hydroponic methods. After passing through the growing tubs, the water returns to a cistern, where a pump pours the water through several trays containing plastic beads. The stream of water is separated into little drops of water in order to oxygenate it. Then it falls back into the fish tank, thus completing the aquaponic cycle.

A tried and tested system

Although aquaponics started in the mid 1980s in industrialised nations such as New Zealand, Canada and the USA, its use in commercial production is still limited and in its infancy. However, its potential is significant, and the specialists interviewed maintain that there is growing interest in Mexico in this technique. “The country has great potential as a player in this new industry”, declares Strassburger. In Mexico, even pioneers in this field have survived the economic crises better than their competitors. Future Aqua Farms, the first Canadian aquaponic project, began in 1998, only seven years before Acuicultura del Desierto. However, whilst the Canadian company no longer exists, the Mexican one will celebrate its fifth anniversary this year, and it has produced hundreds of kilos of vegetables in their 1,500 m2 of aquaponic systems. Strassburger and Estuvillo estimate that for every tonne of fish produced each year, around seven tonnes of vegetables can be grown. Nevertheless, given that there are many ways of configuring the systems, the results of international research still vary a great deal and it is hard to establish general productivity parameters.

‘Aquaponics is for everyone’

Aquaponics is not a technique that only large companies can use.

By using greenhouses, aquaponic farms can be located within a city and offer fresh produce

Below: Small tilapia fry, fish chosen because they are easy to keep and to breed
Page 47: Lettuces in PVC pipes.

Aquaponic farming can be as simple as a fish tank connected by PVC pipes to a square metre of lettuces, tomatoes or chilli peppers. There are several blogs on the Internet devoted to home aquaponics, such as the one created by Rogelio Rodríguez. Strassburger started with a small tilapia tank and a few lettuces in his laboratory. However, the process can be carried out at home with a bit of expert advice. “We design 2.80-cm3 home systems. A small system that does not work exclusively with tilapia; it can be used with other fish too. The point is that we are going to make the most of how harmoniously this system works”, explains Héctor Ramos, of the Acuaponia company. There is a big market for aquaponic produce, even if you just decide to sell it to your neighbours. “These are organic crops, which have a higher commercial value than those produced using traditional systems, because they are guaranteed to be safe and are irrigated using clean water”, stresses the specialist. It is simply a matter of being inventive with these techniques. •

Freshwater and salt water

Several species have been bred successfully in aquaponic systems. However current technology limits the options to freshwater species. Recent research with hybrid species and shrimps in a brackish environment appears promising, according to Evolutions Aquaponics. Species that can be bred in aquaponic systems included tilapia (mainly), bluegill, goldfish, carp and catfish (they can withstand wide variations in the environmental conditions in which they are bred), trout, sea bass and white fish. It should be noted that tilapia have several advantages for commercial operations: they have a short life cycle from hatching to harvest (from six to nine months), tolerate drastic fluctuations in the quality of the water and they can also withstand low oxygen levels for long periods •

SOURCES: CENTRO DE INVESTIGACIÓN CIENTÍFICA Y DE EDUCACIÓN SUPERIOR DE ENSENADA, CICESE (ENSENADA CENTRE FOR SCIENTFIC RESEARCH AND HIGHER EDUCATION), BAJA CALIFORNIA AND CONAPESCA