

# Food Production as Part of a Biobased Economy

Peter van Weel

The challenge for future food production systems is that they must deliver more, better, and more attractive food within the limits of our responsibility to conserve natural resources. Hydroponic production in greenhouses has interesting potential to meet this challenge. Water can be recycled endlessly, and all the ingredients needed for plant growth can be obtained through recycling processes and supplied and controlled in simple and direct ways. In addition, other than organic plant residues, this production method does not produce waste materials.

Understanding and controlling the biological balance in the nutrient solution may be the biggest challenge. We know a lot about plant nutrients, but we need to learn more about the interactions between organic life and the nutrients in the water, as well as the organic life itself. For example, it is known that bacteria can either stimulate or reduce the uptake of nitrogen by the roots. It is also clear that the secretion of root border cells, organic acids, sugars, and organic materials can influence bacterial and fungal growth within the root zone. Understanding and controlling the complexity and interactions of this underwater world, especially in the narrow zone of water surrounding the root system, called the rhizosphere, will allow us to increase growth and prevent problems. The idea that nutrient solutions need to be sterilized to maintain a risk-free plant production system must be replaced with a system based on natural balance. Only then can water replace substrates.

Integration of such a production facility into the urban environment is an important condition for the facility and its products to be accepted by the consumers. Concern about Earth's resources requires us to develop production methods with a

small CO<sub>2</sub> footprint and a zero pesticide footprint. Within these limitations, there are new opportunities for producers of fresh, sustainable, and high-quality foods, produced in an open and controllable way and offering just-in-time delivery.



Automated production of lettuce in floating tray hydroponic system combines crop culture and automation for efficient production.

The high cost of urban land also requires a production method that has a small land footprint. Small-scale operations on rooftops or on small plots are not likely to play an important role, so a new type of greenhouse, suited for integration into densely populated areas, must be developed. Plants require a lot of light for growth. The cheapest light source is sunlight. Replacing sunlight with artificial light is considered by some to be the only route to plant production in an urban environment. However, the huge energy consumption of artificial lighting systems is a strong argument in favor of sunlight. New approaches to capture, guide, or even store sunlight need to be developed. A good example is the vertical greenhouse developed by the Dutch architect Amber Beernink, a long and narrow ten-story building made of double-walled plastic film panels and transparent floors.

The urban environment can play an important role in meeting the sustainability challenges that food production is fac-

ing, since a city provides opportunities for exchanging energy, nutrients, and water. For example, the growing worldwide shortage of phosphates can be solved by recycling municipal waste. Another interesting solution involves using manure, water, heat, and CO<sub>2</sub> from animal production, as suggested and developed by WES Engineering in The Netherlands. A recent study has shown that pig production can produce all the resources required for greenhouse production in a commercially viable way. Algae can be produced on organic waste and sewage water, and a fermentation step can be used to deliver plant nutrients without the risk of transferring bacteria or fungi. Another method to produce fresh water and nutrients from wastewater is the use of a membrane biore-

actor in combination with a reverse osmosis filter.

Municipal waste can also produce the heat, electricity, and CO<sub>2</sub> required for plant growth. In return, in addition to food, a greenhouse can produce a huge amount of low-temperature heat when the sun is shining. This heat can be stored in a large volume of water or transported directly to processes that require low heat, such as drying processes or biochemical production based on living cells and their enzymes, to create industrial products from renewable feedstocks. This diversified, biobased economy will play an important role in the next generation, as we depend less and less on fossil fuels.

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*Photo courtesy of the author.*

## Spain and *la Huerta Urbana*

Jeremy Werner

Diet and food have changed dramatically in Spain with the modernization of the country in the past 15 years. Traditional elements of Spanish food culture, such as the *huerta* and the Mediterranean diet, have given way to mass-market processed foods, with noticeable consequences for the society.

*La huerta* is effectively the home garden or orchard. Going to grandma's for Sunday lunch was all the better knowing that much of it came from her *huerta*. She served it with well deserved pride.

Spain still has a great system of *denominación de origen*, which identifies where agricultural products come from, especially wine, but also vegetables. For example, tomatoes may come from Andalucía, melons from Murcia, calzotes (a type of onion) from Cataluña, and citrus from Valencia. Also still prevalent are the local *mercados*, where urban residents go to buy nearly everything related to food, including fresh produce, meat, fish, cheese, and many other products.

The Mediterranean diet is one of the healthiest diets in the world. The cornerstone of this diet is the variety of locally grown vegetables, grains, legumes, and fruit. Products such as virgin olive oil, saffron, locally raised livestock, and locally caught fish are also important components in Spain. In fact, after Japan, Spain is the world's second largest per capita consumer of fish.

Once, *huertas* and small local farms formed the backbone of Spain's food system, and of Spain's Mediterranean diet. Not so now.

In only one generation, Spanish urban society has completely dropped the concept of home cooking and now seeks nourishment from quick, prepared foods, especially fast food. This shift from fresh, locally grown foods to processed foods has also changed Spain's people. In less than a decade, Spain has become the fourth fattest country in Europe. With that collective



Fresh pickings from *la huerta urbana*.

weight gain has come a sharp increase in diet-related illnesses, such as diabetes, heart disease, and cholesterol problems.

The fresh produce that is now produced in Spain is grown in vast greenhouses in the arid south, with intense use of fertilizers and pesticides. Meat production is now fully industrialized. Fish is farmed or brought in from seas far away, since local fisheries are collapsing. Up to 75 percent of the grains grown in the fertile *Meseta* region of the interior are GMOs.

In short, the Spanish diet has become dependent on industrial-scale processing and importing of food. A generation ago, Spaniards had a real connection and relationship with their food. Now, they have only fond memories and misplaced beliefs. The society shifted from a locally grown, traditional Mediterranean diet to an overreliance on financially focused corporations as the basis of the national food supply.

As we all know, Spain's shift to an economy driven by housing development and massive debt led to a financial crisis. More than 25 percent of the workforce is unemployed, with countless more not reflected in the official figures or severely underemployed. There are frequent reports of hunger, a problem unknown in Spain since the 1930s, and the number of those falling into poverty is swelling.

The challenge is how to feed an economically insecure, high-density urban population that is now completely detached from growing and preparing food. One possible solution is *la huerta urbana* or, effectively, urban agriculture. Spaniards could revitalize the traditional *huerta* with a modern urban twist. There is ample roof area in the cities, and Spain is famous for its sunshine. Following the crash in the construction-driven economy, there are more than enough buildings standing idle, empty, or unused. Hydroponic systems can be very productive in small spaces, and many buildings have sunny terraces for small hydro-gardening projects.

This vision of *la huerta urbana* is a real possibility. Fresh, locally grown, even organically grown food can be produced individually or collectively, improving diets and mitigating rising food costs. In addition to local consumption by the growers, the surplus could be sold in the still-functioning traditional urban markets. The cash proceeds could be used to pay for the necessary equipment, water, and electricity.

Most important, grandma could be invited over for dinner and served real food from *la huerta urbana* of her children and grandchildren.

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