



What is food and why is the current food system unsustainable?

Historically, food has always been local and communities naturally and of necessity achieved and nurtured a status that we would now refer to as "local food sovereignty" and self-sufficiency. The emergence of human dominance in the Paleolithic world of nature was completely absent of the grain-based food system that now prevails throughout the world. It is critical that all of humanity is empowered to return to our original Paleo-diet. Success in this direction will be possible if we simultaneously seek an understanding of indigenous peoples' traditional knowledge and apply our most advanced understanding of life science and regenerative, ecological systems.

Mobilizing the will of the people to navigate in the direction of rejection of the dominant agricultural food system requires: First, that the illusion that agriculture was created for our well-being is discredited; and Second, there must be a viable alternative that can quickly be adopted and propagate worldwide to provide food security for everyone, everywhere, with no family left behind.

Wheat grain, and other grasses, did not come to dominate our lives and our diet because of their good food value. Grains acquired importance as a long-life biofuel - the energy dense "feed" and "food" commodity to power the ancient world. The average person today does not understand that these grains, can only be harvested from the annual variety of the grass plant. Wild meadows and vast grasslands that sustained the massive populations of wild herbivores in nature (in the not-so-distant past) are dominated by the perennial varieties of grasses, that spread by root, NOT by seed. The annual varieties have no capability to compete with the perennial varieties. But the attraction of the long shelf-life and capability to stockpile this valuable concentrated carbohydrate gained an overwhelming economic importance.

The energy cost of growing this commodity of grain was the labor of people and animals enslaved for the production of this commodity, leading to millenia of the nearly universal subjugation of the people to a global Warfare Economy. The conquered and enslaved tribes and Nations labored to produce a tribute taken in grain by the Kings and Emperors of the Agrarian era. Not only did this system enrich the powerful, but over elapse of decades and centuries of firing the forest and tilling the soil, the ecology of the lands of the conquered peoples were

gradually destroyed and their lives were impoverished. These long exploited lands and people vanished into the ever-expanding deserts of the world.

Once this truth is revealed then our minds are freed to think about food rather than agriculture. The people today need to arrive at a consciousness that frees us from the Warfare Economy of the past which continues to devastate our natural wealth today. We can be freed from the limitations of the commodity food system that constantly battles with nature and relegates food to a product of technology rather than being the fruit of a natural ecosystem.

The greatest challenge at this time, is to put a stop to the universal destruction of healthy ecosystems with the onward expansion of agriculture into the unspoiled ecologies of Africa and South America. The outcome of remaining on this path of destruction results in poverty for all; a downward spiral that ends in an Extinction Event for all of life on Earth. Indigenous people, displaced from their land and with natural habitats destroyed, find that independent living is no longer viable, while the rest of the human population is long divorced and separated from nature and has learned to live with scarcity as a result of our many Millennia of subjugation by the few, the powerful 1% who still, now through corporate control, rule over and exploit people and planet.

To break out of this deadly scenario, the most important issue is to rediscover free energy, food and water that is regeneratively produced within the footprint of our own living space. This free energy is solar energy, by which I mean sunlight freely available for photosynthesis (producing carbohydrates) and transpiration (producing clean water-from-air) by plants. Today, substantially all of our food is grown with petrochemical inputs with a necessity of significant mechanization (powered by fossil fuels) and application of toxic chemicals (including synthetic fertilizer) and dangerous GMO technology - the Agribusiness formula for field production of grain, soyabean and sugar crops.

The energy investment also includes the transportation from the farm to the food processors and onward to the wholesale industry for packaging and branding for the final leg of distribution (processed, refrigerated or frozen) by the retail supermarkets and stores. Then additionally, there is the travel of the consumer to collect the food at point of sale. Refrigeration and cooking of food by the family and also the delivery of food to the table by the restaurant industry is usually not accounted as a further energy cost to the food system but this represents a significant portion of the energy consumption in the food sector. We are also more recently aware of that approximately one-third of food is lost to spoilage on the long and complex supply line from field to table.

Is growing food indoors a real alternative to field agriculture?

The greenhouse sector has competed by growing food out of season and close to the point of consumption, offering a fresh product to the consumer. Today we recognize the value of reducing the "food miles" with the local growing of food. While it is a convenient sales pitch for the Urban Agriculture sector to focus on this elimination of food miles and other associated energy costs, it is deceptive marketing because the energy cost of operations of growing food in all seasons in a greenhouse now accounts for 50% of the cost of this food.

If we go back to the very early success of the greenhouse sector in the 60s and following the Second World War the cost of energy for the greenhouse operations was about 5% of costs of production. After the energy crisis of the early 70s, and onward from that decade, the cost of energy for heating and cooling (by ventilation) increased to approximately 30%. But with the energy spike to \$100 and highs of \$150 per barrel for oil, the energy inputs of the greenhouse sector (per pound of food delivered) now far surpass that of field-grown food, with the greatest of food-miles, even air-miles. Therefore, there is a false energy (and carbon footprint) assumption that favors the year around growing of our fresh food in conventional greenhouses.

But, what about the high-tech alternative for indoor growing of our food in "food factories"?

Urban Agriculture is now burdened with another untruth by new entries into the food sector who make claims that recent "high-tech" advancements including LED lighting will make field and greenhouse-grown operations uncompetitive. But any organization that is prepared to do due diligence to examine this claim will see that the hype is unfounded. I hope that this warning will be heard above the noise and that we may avoid significant investment losses in these so called "food factories" within warehouses that are opaque to sunlight and totally dependent on electrical power. Let's be clear that lamp conversion of electricity is very expensive compared to free sunlight and results in a spectrum of illumination that is unlike sunlight and at best is a poor substitute for the natural energy of the Sun reaching the Earth at 1 kilowatt per hour per square meter. With the cost of lighting comes also the cost of heating, cooling and dehumidification of the food factory growing environment. If you provide even 50% of natural sunlight equivalent in the form of the most efficient artificial lighting the cost of energy in a closed atmosphere environment system will be twice that of a conventional Greenhouse. One of the only crop systems that may prove to break even is the Cannabis growing operations. In this particular case it is then also sad to conclude that such operations which are aimed at human health and recreation will have such a high carbon footprint that responsible codes for regulation of carbon and GHG emissions would prohibit these operations, or if permitted then the cost of carbon tax might make these businesses unprofitable as well as marking them as extremely high contributors to global warming.

If the Urban Agriculture sector is as irresponsible as the Agribusiness sector and if both are dominated by big money, big energy, Pharmaceutical and Multinational Agribusiness interests, then Urban Agriculture will contribute only to the confusion rather than being part of the solution to our global food crisis. Unfortunately, this analysis predicts that indoor growing is not, with present technology, a solution to our global food crisis. If indoor food is to become an answer then what is needed is innovation that eliminates the difficult energy limitations of the Greenhouse, which is the mission of SolaRoof.

The SolaRoof technology must be differentiated from these previous, failing Food Systems because it offers a radical energy solution. We describe our general design for vertical farming under natural sunlight as being "greener than a greenhouse". This SolaRoof structure is branded as the POD, which is an OpenSource generic name for a multi-leveled platform that is adaptable

everywhere in the world to any climate and culture. Our innovation is modular in design and accessible at various scale from the very small TinyPOD (for households) to the DIY Enterprise version called WikiPOD and the AgriPOD for the professional farmer. The large-scale module with a footprint of one acre and more, is called the CityPOD.

What about the capital investment for food and the comparative cost of the POD?

The spend on a conventional Greenhouse is \$10 to \$20 per square foot. The higher capital investment reflects the cost of conventional year-around crop production. The lesser amount is a typical investment for the seasonal operation of a low-tech Greenhouse having little or no investment in environmental control. In my experience over a period of 40 years of professional engagement in this sector in over forty countries I have seen that Growers achieve an annual income that is approximately the same as their expenditure on a greenhouse investment. The higher the investment, the higher is the revenue and yield. Furthermore, the price of food as a commodity has risen approximately in step with the increased costs of materials and Technologies for the construction and mechanical installations for the all season Greenhouse. The greenhouse operator has the goal of recovery of investment within 3 years and in the past two or three decades this is no longer achievable, which accounts for the industry being stagnant or even declining due to lack of profitability which is itself due to the high and ever increasing cost of energy.

The SolaRoof POD platforms have a competitive Capital cost as compared to the all season Greenhouse, which is approximately \$20 per square foot. However we utilize land more economically by means of the vertical farming configuration. On the ground level or subgrade we have the blue operations which encompasses the Aquaculture systems. On the upper two floor levels we have the green operations which are plant cultivation with sun loving crops above and vegetative (leafy) crops below. Between the blue and the green we may also have a ground floor for supporting operations and administration, and this vertical layout of three to four floor levels is a consistent design strategy that we call BlueGreen design.

As a rule of thumb the cost to the consumer for food has plateaued for two or three decades adjusted for inflation (and/or the deflation of the value of money). Sometimes the pitch for urban agriculture is based on a profitability of being so close to the consumer that the growing operation can fetch the consumer price of food for their products. In fact most of the business plans that I am aware of for urban agriculture rely on securing a relatively high price for organic food in an Urban Market willing to pay a premium. This is diametrically opposite in direction to the intent of many Urban Agriculture proponents who see the purpose of these developments as opening up a market for reasonably priced and better quality food in low-income "food deserts" in City centers. Will it be the mid to high-income earners who gain the benefit of Urban Agriculture operations being gifted public land and then exploiting desperate job markets for the sake of producing high price food that is out of reach to the average consumer?

At SolaRoof we care about these issues and we can answer these challenges with disruptive innovation that is very competitive on Capital Investment and

eliminates the great burden of the energy cost of food. Our operations can expand rapidly, delivering organic food at competitive price in high volume for the mass-market represented by the general public's need for fresh, nutritious foods. This capability will enhance the Health and Wellness of everyone and that is a dividend for society. We operate on a zero carbon footprint and that is the way to save the environment. Our job creation will be permanent and lasting with a resilience to Climate Change that brings security to communities already hit by extraordinary economic damages of floods, hurricane, drought, wildfire and seismic disasters. SolaRoof food operations are sustainable and design to be highly resistant to the impacts of increasingly damaging natural catastrophes.

PODnet provides SolaRoof POD Vertical Farm and habitat platforms in the context of the failing "field agriculture" mechanized and oil dependent food system and the stagnant or declining of the Greenhouse sector, as state-of-art for food grown "indoors". Energy is the key issue for both and I have explained how the SolaRoof "Closed Controlled Ecological Environment" building with a transparent roof and wall system is able, with Inventions that efficiently use natural sunlight, to effectively eliminate energy as an issue. Our innovative building system that we call the POD Vertical Farm also results in a reduced Capital cost comparative to other building construction, including conventional greenhouses.

The next most important question after the energy issue and the capital cost issue is the question: how much food can SolaRoof, as a sustainable, regenerative "indoor" food growing system, be capable of producing?

If we substitute SolaRoof indoor growing for field agriculture and/or greenhouses, then can we grow enough food for everyone?

Even while we do not yet have commercial scale food growing operations in our POD Vertical Farming platforms, precisely because this invention is just now moving into the phase of Proof Of Concept (POC), we can never-the-less draw reliable conclusions based on the performance of the greenhouse sector which has a large-scale success in growing food indoors in natural sunlight, despite the high energy costs. We know that outdoor (seasonal) intensive gardening can produce 10 pounds of vegetables per square foot per year. This is high quality, nutritious food, but it is harvested as a seasonal crop and if organic, then requires intensive human labor inputs (in our "battle with nature"). But agriculture substitutes mechanization to undertake extensive field cultivation, which is dependent on fossil energy. The problem is that the agriculture sector focuses on grain crops, worldwide and the typical maximum yield is only 0.1 pounds of food and feed (20% of global harvest is feed for animals) per square foot per year. This is 40 times less than the intensive cultivation by the master gardener can produce (fresh produce are less energy dense, because of the higher percentage of water). The conversion of sunlight to carbohydrates by the grasses is less than 1%, except for sugarcane that may reach 3%. Tree plantations, especially palm oil can reach 10% efficiency. Intensive gardening approaches 20%, and our POD Vertical Farming can exceed that standard because we have multiple leaf canopies and CO2 enriched atmosphere. When we combine our plant production and algae culture, then sunlight conversion to carbohydrate and oil-from-algae can reach an efficiency of 40%. With the closed atmosphere, controlled environment within the POD we can extract another 40%

efficiency because we harvest the transpired moisture by condensing "water-from-air", generating a daily source of pure water at a rate of 1 to 2 pounds per square foot per day of leaf canopy in sunlight. With this 80% conversion comparative to the 1% performance of field agriculture, SolaRoof is certain to deliver, from the footprint of the homes that we live in and POD Vertical Farms in the neighborhood, more than sufficient fresh healthy nutritious food to feed the people; and abundance of food for everyone, everywhere, in any climate.

The requirement is therefore, to universally adopt the new paradigm of Ecological Architecture that is enabled by my SolaRoof inventions. The cost of our built environment will be radically reduced, to the point where all people have a home that provides for a dignified independent living for people, which is called "livingry". Our Ecological Architecture is capable of lifting people out of poverty permanently and eliminating hunger, bad water and energy scarcity. As Nelson Mandela said poverty is man-made and together, we have with the power of our own actions, the capacity to make poverty history.

Richard Nelson



Closed Controlled Ecological Environment