

Farm Table

A paper on a sustainable food system



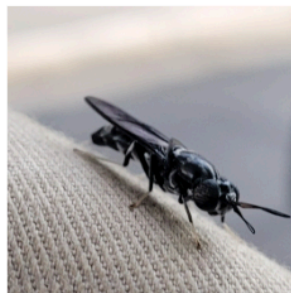
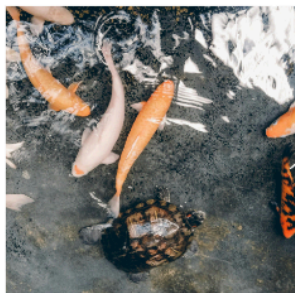
Future Acres Urban Farming, LLC.

Grow Food

Natural Fertilizer

Eco-Friendly Feed

Reduce Food Waste



Foreward



"Technological innovation is moving the world forward so quickly that I wonder if forward is always the right direction. We have a moral obligation to look back and fix lingering problems that we missed... or caused. I want to create a resilient society so there is a world to innovate for in future generations."

Dave Littere, Owner/CEO

The goal of this paper is to simply raise awareness. To make the reader aware of where their food is coming from, environmental impacts of food systems, and basic biological and natural “technologies” that we can use to reduce negative impacts of humanity’s ventures on the planet.

This paper will not solve anything outright, rather shed light on issues that most people are not aware of. This topic, in turn, will spark people’s desires to help and generate innovation in spaces that really need it... not the next app. Describing the issues in the human food system and promoting resilient societies will help people change the way we eat over time. We can return nutrition to the soils, support farmers, get rid of the ever-persistent pesticides that are literally in the air we breathe and affect each of our microbiomes. The way we pursue these goals is by talking about them. With enough resilience, community engagement begins and conversations can be had with every level, from the elementary school lunchroom to federal policymakers.

Future Acres Urban Farming is focused on the dirty jobs. Bringing farming to the urban setting exposes more people to how truly intricate the food system is, along with tons of potential innovation - not so much to progress a technological society, but to preserve and restore what we currently have.

Table of Contents

Introduction.....	4
Sustainability Goals.....	5
Natural Technology.....	7
Urban Farming Technology.....	9
Outlook.....	10
References.....	11

Introduction

Urban farming has emerged as a unique industry with many different avenues of approach. For those who have seen an indoor high density vertical farm, it is truly a remarkable feat of innovation. Vertical produce farms make the thought of growing food on a space ship more likely.

Technology has driven the urban farming industry forward for the last few decades, with focus areas being increased lighting efficiency, faster growth rates, etc. At the end of the day, you're still growing plants, something nature has accomplished long before our time in all sorts of conditions.

Cultures have been able to take advantage of the natural systems taking place in the environment to grow food in undesirable locations. Aquaponic farming, the use of fish waste as nutrition to grow plants, has been attributed to the Maya and Aztec civilizations in the West, where they grew floating gardens on top of lake surfaces, and the Far East civilizations using flooded rice paddy fields alongside hill slopes, rife with aquaculture⁽¹⁾.

In addition to growing food, urban farming entrepreneurs have been able to find ways to recycle it. Recycling food waste is an integral part of any urban area due to high population densities. It has a range of benefits from reducing landfill capacity and greenhouse emissions to adding nutrition to farmland soils. Food waste recycling has many forms: composting, valorization, anaerobic digestion, and insect bioconversion, among others. These are the most common forms of recycling due to the added benefit of obtaining products after the recycling process takes place - the process of composting yields compost, insect bioconversion leaves you with massive amounts of insects - all of which can be sold in addition to getting paid for removing and processing the food waste.

The necessity of food waste recycling has become a trending topic among communities and local governments over the last few years. Many Northern Virginia governments are experimenting with food waste pilot programs and contracts to determine what is a feasible option for such a large scale operation.



Sustainability Goals

Sustainability... a popular hashtag and keyword which ranks high on algorithms. You can find these words, such as “green,” “eco-friendly,” “organic” on all of your products nowadays. Sustainability refers to a method of harvesting or using a resource so that the resource is not depleted or permanently damaged⁽²⁾. This is very important to keep in mind while being inundated with the product and service keywords, but also important to contribute to setting goals for communities. By setting a sustainability goal, most urban areas focus on greenhouse gas emission reduction, making a higher percentage of cars electric, or public transportation. These are all important to instill at some level, but the communities that empower these goals will be missing the mark. The true resources we need to sustain comes from nature. There is no sustainable source of petrol because we are extracting it from the earth without a method of replacement. We have unfortunately built our society around it, so we have to do our best to mitigate the consequences for the time being.

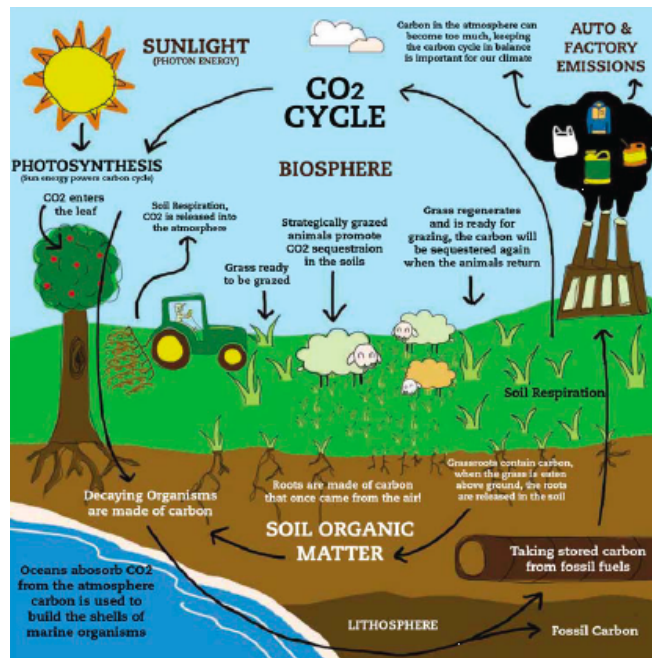
American farmland soils have been depleted over the last 40-50 years due to high density monocrop farming, chemical fertilizers, federal export incentives, and financial policies. In a 2014 conference, a senior UN official stated “If current rates of degradation (of topsoil) continue, all of the world's top soil could be gone within 60 years.”⁽³⁾ This claim, along with the Paris Agreement’s “under 2 degree global temperature change,” are the topic of click-bait articles and their narratives have been used for instilling fear rather than change. The underlying intent is fundamentally good, but the messaging and goals have caused cultures of backlash. Soil degradation does reduce crop yields by increasing susceptibility to drought stress and elemental imbalance⁽⁴⁾, which affects food security and the supply chain.

Additionally, American crops have to be genetically modified to deal with the devastating pesticides and herbicides we spray on them to increase yields. Again, while the underlying intent of growing more food via reducing insect infestation and weed competition is fundamentally a good thing, our previous solutions have caused long-term issues that we now have to deal with.

What most people don’t understand about the carbon cycle is when processes like rotational grazing, free-ranging poultry and other bio-mimicry practices are used in regenerative farming, the carbon emitted from livestock is offset by the growth stimulus endured by the

grasslands and the manure decomposition into the soil, which adds beneficial bacteria that require more carbon from the plants and locks it away in the soil.

When looking into sustainability goals, it is important to keep the above example in mind. All talks of supposed environmentally-friendly practices may not cover some truly important topics. There are many things we as individuals can do, such as reduce consumption, support your local (regenerative) farmer, and bring environmental issues you are passionate about to your local representatives. Business have similar opportunities by addressing these issues to help meet AND EXCEED sustainability goals set by governments. Funding these business startups and innovation has been growing but still needs to be addressed.



Natural Technology

One solution that Future Acres Urban Farming is seeking to implement is reducing pre-consumer food waste via insect bioconversion, specifically the larval stage of the Black Soldier Fly (BSFL). These insects are voracious decomposers of all sorts of food waste, and they grow very rapidly in a short amount of time.

They are preferred over other insects due to their wide ranging appetite and the speed at which they eat. BSFL also grow approximately 25 times their hatchling size over the course of their eating window, which is about 18 days⁽⁵⁾. They naturally convert many forms of wasted nutrients into valuable resources, such as fat (15%-49%) and protein (40%-44%)⁽⁶⁾ as well as many vitamins and minerals, such as calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium and zinc⁽⁷⁾. Due to these factors, and also the fact that they are native to the U.S., the adult flies don't eat food and are not considered pests, and the larvae are easy to grow in a vertical setup, we are implementing a vertical farming system where the product is the BSFL and the input into the system is food waste.

With an average of 18 days, BSFL food waste recycling beats out traditional composting in time needed for product, efficiency, land usage, and Global Warming Potential- composting at nearly double the GWP of BSFL⁽⁸⁾. Seeing the value of this enterprise, Future Acres Urban Farming is exploring cost effective ways to reduce as much food waste in Fairfax County, VA while at the same time producing as many BSFL as possible. Industrial real estate is preferred to set up a system but is currently in high demand and price. Office real estate is lower price and demand, but there are zoning and policy issues with implementing our system in these spaces, not to mention 0% landlord approval rates.

As a proof of concept, we have developed a mobile BSFL operation in an enclosed cargo trailer. There are many challenges with doing it this way, but it will show our customers and the community that it can be done. Stating the necessary improvements to the system will also advocate for more assistance in setting up a larger stationary system. In order to research BSFL bioconversion efficiency, Future Acres Urban Farming has secured a research grant through the [SARE](#) organization. The budget in the grant includes three networking events, where we will be able to go to the Virginia Cooperative Extension office in Fairfax, the Rooting DC urban farming

conference in Washington DC, and the RVA Urban Ag Kickoff in Richmond, VA to showcase our setup and demonstrate the food waste recycling potential of BSFL.

BSFL rearing offers a solution to a few problems: properly upcycling food waste into valuable nutrition and providing a truly sustainable feed source for livestock. Not to mention the benefits associated with frass (discarded remains) that are still being researched as a soil amendment. We have the opportunity in Fairfax County to establish a precedent of creating a renewable resource to give back to the farmers, closing the farm-to-table-to-farm loop. Raising BSFL requires relatively little start up investment, as they can grow in many different environments. To make this a viable business, however, some modifications should be made to optimize efficiency and maintain some profit.



Due to the BSFL nutritional content, they make for a useful protein alternative and fat source for livestock feed. I recently visited a livestock feed manufacturing plant to see how the current process is done. This company, as I'm sure others do, use soy as the protein source and a mix of mostly corn for the fat source. Both of these crops are important, but are subject to stock market volatility and seasonal weather uncertainties.

Processing BSFL into its nutritional parts *could* be an effective supplement to soy and corn - currently being researched. Insect protein has been shown to be easily digestible by ruminants⁽⁹⁾ and has shown promise in poultry and salmonid feed systems⁽⁶⁾. Insect protein is also commercially available in a lot of pet foods, and is included in some human food as well. Because of the poultry and fish's natural tendency to eat insects, minimal processing needs to occur to feed these livestock, reducing cost. Poultry have no problem eating BSFL whole, for example.

Urban Farming Technology

When discussing sustainability, fishmeal production also has to be addressed. Fishmeal is the main protein source and fish oil is the main fat source in feed for all aquaculture livestock, and is produced in a very unsustainable way. It requires large amounts wild caught and some farm raised fish, which are processed into protein and fat. Aquaculture livestock have responded well to fishmeal and oil in the feeds the industry is currently using, and these two products are used as the control/comparison group in studies.

Today's aquaponic farming systems are pretty advanced. Fish are kept in a large container, where circulating water carries the fish waste (Ammonia and solids) out of their container into multiple bioprocessing stations. From there, bacteria break down most of the fish waste via the Nitrogen cycle, where the byproducts act as a valuable and accessible source of nutrition for plants. The nutritious water is then circulated to some type of plant growing operation, where the nutrition in the water is absorbed by the plants, and returned back into the fish container as fresh and clean water. Additives are included for nutrition and minerals that lack from the fish waste, but overall the systems are pretty effective.

The fish waste acts as the primary and natural source of nutrition for the plants, when properly processed by the bacteria, replacing industrial-made hydroponic chemicals in hydroponic systems.

A lot of research is currently being done to figure out replacements for fishmeal and fish oil, and a promising source is BSFL. I believe that Future Acres will one day be in the position to test BSFL-based feed in aquaponic systems. By creating a renewable feed source for aquaculture, we should be able to incorporate a aquaponic vegetable growing operation in conjunction with our BSFL food waste processing system. That is what a productive and sustainable urban farm should look like.

THE AQUAPONICS CYCLE

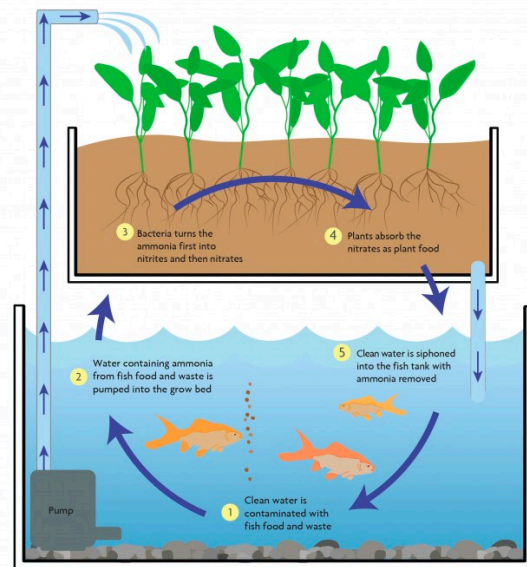


Illustration by Jillian Helvey
Source: aquaponichowto.com

Outlook

The way that urban farming is becoming a topic of conversation in many municipalities is very encouraging. The right conversations are being had at high levels of government, within working groups, and many other places. Legislation is being proposed in some places for wider access to food via urban farming, expanding the industry's reach and abilities.

Supporting your local urban farming community is important, and many new innovative approaches will be discovered in the years to come. Urban farmers can be the link that closes the food loop and creates resilient societies. Future Acres Urban Farming is an active member in this endeavor in Fairfax County, VA, helping them add to and reach their sustainability goals.

I hope that this paper was able to shed light on some issues in food systems and urban communities and encourages you to get involved. I love talking about these topics and am always open for a conversation. Go grow!

Future Acres Urban Farming

Fairfax County, VA

www.futureacresfarm.com

Dave@FutureAcresFarm.com

References

1. [Britannica](#)
2. [MW Dictionary](#)
3. [Scientific American](#)
4. Lal, R. **Soil degradation as a reason for inadequate human nutrition** in *Food Sec.* 1, 45–57 (2009). [LINK](#)
5. *Hermetia illucens* [Wikipedia](#)
6. Sharvini Siva Raman, Lindsay C. Stringer, Neil C. Bruce, Chun Shiong Chong. **Opportunities, challenges and solutions for black soldier fly larvae-based animal feed production** in *Journal of Cleaner Production* Volume 373, Article 133802. November 2022. [LINK](#)
7. Shengyong Lu, et. all. **Nutritional Composition of Black Soldier Fly Larvae (*Hermetia illucens* L.) and Its Potential Uses as Alternative Protein Sources in Animal Diets** in *Insects* 13(9), 831. 2022. [LINK](#)
8. Adeline Mertenat, Stefan Diener, Christian Zurbrügg. **Black Soldier Fly biowaste treatment – Assessment of global warming potential** in *Waste Management* Volume 84, Pages 173-181. 1 February 2019. [LINK](#)
9. Assar Ali Shah, et. all. **Nutritional composition of various insects and potential uses as alternative protein sources in animal diets** in *Animal Bioscience* 35(2): 317–331. February 2022. [LINK](#)

Graphics

1. Wasted Food Scale - [U.S. EPA website](#) (page 4)
2. Carbon Cycle - [Holistic Management International](#) (page 6)
3. BSFL Rearing Unit Example - [The Straits Times](#) (page 8)
4. Aquaponic Cycle - [Aquarium Edge](#) (page 9)