

CLIMATE CHANGE AND FOOD SECURITY IN CITIES

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Summary: Rapid urbanization and large scale food production both heavily dependent on fossil fuels are arguably the most significant contributors to climate change. They are also increasingly recognized as potential tools in mitigation and adaptation to climate change. Climate change has already affected food production systems leaving loss of crop, grain shortages, and increased commodity price in its wake, all of which undermine food security a fundamental human right. This study establishes that Urban Agriculture is a multipronged tool for adaptation and mitigation to tackle climate change, and is the effective tool to address food security challenges in the cities, educate and reconnect urban and peri urban farms and people to assure food and climate security in the cities.

Key Words: Urban Agriculture, Climate change, Food miles, Food security, Organic, Waste, Compost, Garden, Farm, Biodiversity, Community.

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CLIMATE CHANGE AND FOOD SECURITY IN THE CITIES

I. INTRODUCTION

Human activity has set in motion far-reaching and unstoppable changes in regional temperatures, precipitation and in the composition of our atmosphere resulting from growing emissions of Carbon dioxide (CO₂), Methane (CH₄) and Nitrous Oxide (NO₂). Climate change studies have established that warming of the climate system is unequivocal and that it has had a discernible global influence on observed changes in many physical and biological systems (IPCC, 2007).

Agriculture & Climate Change

Though the extent and nature of the effects of climate change on agriculture has not yet been accurately forecast; its impact so far on diverse farming regions of the world has been profound (McClellan, et al., 2005; FAO 2007; Revkin, 2008). Water sources have become unpredictable; with excess, little or no rainfall and flooding and inundation in coastal areas (Brown, 2006; Dore, 2005; Hopkin, 2005). California alone has put the 2008 drought losses at more than \$300 million, and economists predict that losses in 2009 could swell past \$2 billion, with as many as 80,000 jobs lost (McKinley, 2009).

The agricultural sector is estimated to contribute anywhere from 28-33 percent of global greenhouse gas (GHG) emissions. Large-scale agricultural operations particularly dependent on fossil fuels, contribute to GHG emissions from soil carbon, methane from large animal feedlot operations (23 times more powerful than CO₂ as a GHG and responsible for 18 percent of global greenhouse gas emissions) and synthetic fertilizers release nitrous oxide, a gas with 300 times the warming power of CO₂ (FAO, 2006).

Combined with the 13.5 percent emissions generated during the transportation of food - average bite travels 1200 miles from field to fork - *agriculture is the single largest contributor to global warming.* (FAO, 2006; IPCC, 2007).

If climate change mitigation goals are to be met, international climate policies, negotiations and treaties must consider the crucial role of agriculture (Nelson, 2009).

Impact of Urban Development

Urban population growth has a direct impact on this relationship between agriculture and climate change.

Urbanization is an inescapable part of our economic growth models. We have now crossed the threshold of 50% of the world population living in cities (UNFPA, 2007). Demographic analysis indicates that there are 70 million new urban-dwellers each year, a large proportion of who live in developing countries. It is forecast that two thirds of the population will live in cities by 2025. By 2015 about 26 cities in the world are expected to have a population of 10 million or more (Watson, 2001).

The urban population in developing countries is growing three times faster (3 percent annually) than

the rural population (less than 1 percent annually). To feed cities of this size – at least 6000 tons of food is expected to be imported each day (Nugent and Drescher, 2000).

Current agricultural production and consumption is dependent on cheap water and cheap energy for nitrogen-based fertilizer, agricultural processes and transportation all of which are already significant contributors to climate change.

Increasing fuel prices, changing climate, growing food shortages and increasing prices of food have increased our awareness of our global dependency on fossil fuel. There is a huge untapped opportunity to positively impact climate change through reformation of our energy consumption pattern, and reducing waste through ‘Urban Agriculture’ - the practice of cultivating, processing and distributing food in, or around an urban area.

UA offers powerful tools to address urban food security, while mitigating and adapting to climate change. This paper explores “Urban Agriculture” as a tool to address climate change and food security in the cities.

II. METHODOLOGY

a. Review of Literature

A detailed review of literature on climate change, agriculture, UA and food security was undertaken as part of this research; various online links were perused and corroborated using publications in established journals.

b. Questionnaires

Questionnaires were shared via email, teleconferences were conducted and Instant Messages exchanged with producers and farmers in 100 -150 mile radius of the San Francisco (Bay) Area, California, USA and in 100-150 km radius of Bangalore City, India. Urban agriculturists in the Bay Area, California USA, Vancouver, BC, Canada, Mumbai, India; Sydney and Adelaide, Australia were contacted and also a few restaurants in the Bay Area were contacted. Urban and peri-urban farms were visited in the Bay Area, CA, USA.

Questionnaires were also distributed to consumers of produce ranging in ages 25-75 years in the USA, India, Canada and England. Personal interviews with consumers were conducted in farmers’ markets of Pleasanton and Fremont, CA, USA. Phone interviews were also conducted with grocery store owners in Bangalore and New Delhi, India.

Sample areas of questions:

1. For consumers:

Understanding of food security; food sources that the consumers rely on; frequency of visits and reasons for food preferences; changes observed in food availability and prices; possible reasons for changes if any observed; knowledge of food production and marketing; knowledge and practical application of composting organic waste at homes, opinion on public/community/personal edible gardens.

2. **For producers:**

Understanding of food security; area under cultivation; water and energy source for farm operations; subsidies or government support for alternative energy use on farms; distance produce travels from the farm; what a 'food secure' urban community would look like; how much local food productions can supplement the diets of residents?

3. **Common questions to producers, consumers and county officials involved in management of farmers markets and urban waste:**

Where can urban food production occur; is there a need and opportunity for new distribution outlet; how much can an urban and peri-urban food system support environmental efforts such as redirecting waste or managing wastewater; what kinds of technology would advance food security and by how much; what are changes required in public land management; what are the policy changes required for land management and food safety; what are roles of community gardens, farmers markets in urban areas; how are energy and water requirements to be met for UA in the climate change scenario?

III. RESULTS AND DISCUSSION

This section is a compilation of feedback received from farmers, urban dwellers, government, NGOs and grassroots staff along with the information gathered through review of literature. They are categorized under suitable subsections:

3.1 Climate Change

About 95 percent of the responses received from consumers, producers and people working in grassroots or public departments agreed that 'something was not quite right with the climate'. Few farmers who were geographically located in water sensitive areas in both US and India were able to point to a definite trend.

Organic farmers interviewed in CA and India mentioned they were better equipped to handle water shortages because of regular use of mulch and compost. Few people living closer to the farming communities in the peri-urban areas of Bangalore, India reported increased frequency and intensity of insect infestation, uncertain rainfall followed by dry periods, pollination problems and a decrease in quality of produce both in their own gardens and produce bought from the farmers. Namdhari, the Organic Grocers from Bangalore, India were shifting to greenhouses based production to reduce climatic induced produce supply impacts.

“Pest incidence and weather changes have definitely disturbed our forecasting models. Controlled production is the way forward”. - Mr. Verma, Namdharis Fresh Store, Bangalore, India catering to fresh produce needs of approximately 160000 families per month

3.2 Location and frequency of produce purchase

Most families who responded to the questionnaire shopped at least once a week for their produce. About 70 percent of the consumer responses in the US indicate they buy much of their produce from

conventional regional or national chain grocery stores. The rest were active participants in Community Supported Agriculture (CSA), and shopped at Farmers Markets or organic produce stores such as the Whole Foods.

Reasons quoted by consumers in the US who opted to shop in chain grocery stores instead of farmers' markets or CSAs ranged from 'lack of time to visit farmers markets which are usually held in weekends or mid-week and have limited number of hours, cost (conventional stores are cheaper), convenience of getting almost all household needs under one roof, easy access (stores are open through the week from morning to night), neater appearance of the produce (packaging) and food supply miles not being a priority.

People who shopped at farmers markets did that because 'the produce was fresh and food miles mattered'. They believe shopping at farmers markets or CSA's helped local farmers and the environment in a positive way; because they trusted the source; and because all known incidences where food safety failed were in large scale commercial production units. Some of the respondents who got their produce from farmers markets or CSAs did remark however that sometimes they did miss not eating non-seasonal produce.

In India much of the older group of responders bought produce from traditional markets, shops near their homes or from mobile (cart) sellers. Among the younger people a definite trend was observed in their reliance on trendier chain stores for produce. Most quoted reasons for this are similar to respondents in the US. In both the US and in India the consumers mentioned that produce bought at farmers markets or traditional markets tasted better and they enjoyed the interaction with the growers.

Consumers in the US, India, Canada and England mentioned that traditional farmers markets or CSAs were more likely to sell only seasonal produce, which was not appealing to people who are attuned to eating out of season produce shipped in from long distances.

3.3 Composting

Composting is practiced more among households with yard space. More than 90% of people interviewed did not know that organic matter from yard or kitchen ends up in landfills. None knew about the contribution of landfills to climate change. About eighty percent responses from India mentioned they would be willing to compost in their apartments or small yards if they had access to bins and training or if they were able to give away the compost to others who could use it. About 75 percent of responses from the US indicate that there is an assumption that yard and kitchen composting is time consuming and has potential to rodent and other infestation. There is also a common assumption that compost may smell and trouble neighbors.

3.4 Urban Edible Gardens

About 90 percent of the responses to the questionnaire shared in the different regions of the world mentioned that cities must bolster food supplies locally to make up for anticipated drought or other climate-related shortages. People opined that this will create an opportunity to re-build stronger local food systems across the countries rather than looking elsewhere to meet their needs.

Almost all respondents were enthusiastic about giving up their lawn to cultivate edible gardens. In the same note, more than 90 percent of the respondents mentioned lack of time and expertise as an issue to get into gardening. They responded positively to the backyard sharing concepts such as <http://hyperlocavore.ning.com/>, and help with gardening and sharing garden produce such as <http://www.spinfarming.com/>, <http://www.cityfarmboy.com> and <http://myfarmsf.com/>. Many had concerns on safety and cleanliness of produce growing in public places such as parks or open spaces.

3.5 Urban Agriculture and Food Security

Urban Agriculture is widespread throughout the world. An estimated 14 percent of the world's food is produced in urban areas (Armar-Klemesu Smit, 2000; Smit, 1996). In Kathmandu, Nepal, 37 percent of food producers meet all their household vegetable needs and 11 percent of animal product needs through their own labor (Rees, 1997). In Dar-es-Salaam, Tanzania, over 67 percent of families are engaged in agriculture, and Cairo reports 80,000 head of livestock located within the city (UNDP, 1996). In densely populated Hong Kong, 45 percent of local vegetable needs are met through intensive cultivation on only six per cent of the land area (Garnett, 1996). In Australia peri-UA constitutes as much as 25 percent of the total agricultural production in dollar terms. This production occurs on less than 3 percent of land used for agriculture in Australia's five mainland states (Houston 2005).

In the United States, the Victory Garden movement made a substantial contribution to feeding the nation during World War II. By the end of the war, more than 20 million home gardens were supplying 44 percent of the produce consumed in the country.

It was estimated by the United Nations Development Agency in 1996 that 15 to 20 percent of the food produced in the world is produced by some 800 million urban and peri-urban farmers and gardeners.

Interviews with several grassroots community organizations such as Peoples Grocery, City Slicker Farms, oaklandsol.org, Growing Power, Angelic Organics, mycityfarmer.com, fullcirclesunnyvale.org, urban and peri-urban farmers including bee keepers, and government agencies such as parks and recreation department and public health department reveal that successfully managed UA including backyard and community gardening could potentially meet up to 30-40 percent of the produce needs of a city.

“City Slicker Farms produced about 8000 pounds of food on its farms, and 15,500 pounds from the 75 backyard gardens.” CEO, City Slicker Farms, Oakland, CA. USA.

This coupled with farms in urban and peri urban areas in a 100-150 mile radius could potentially provide for all food and dietary needs of the city.

“The more people grow their own food, the deeper understanding they get about food and agriculture. I think that it is very very important. However, various kinds of urban gardening will not satisfy the food and fiber needs of the cities. We will always need farms. If each city had its own ring of farms that were providing to the city, that would be ideal.”
Judith Redmond, Co-Owner of Full Belly Farm, CA. USA.

Thea Maria Carlson, Program Coordinator of the Urban Initiative, Angelic Organics Learning Center (<http://www.csalearningcenter.org/>) responding via email mentioned 'Havana, Cuba is one good

example of how much food can be grown in urban areas' adding, 'given the immense amount of human creativity that exists, I am sure that we could find a way to grow all the food we need in urban and peri-urban areas'.

Dairy products needs including meat and cereal, cannot be met without the support of farmers in the peri-urban areas. Much of the produce grown by small farmers in the Bay Area in California is sold locally in California and the West coast of USA.

“More than 75% of this produce is sold through farmers markets, wholesale, direct sale and through distributors in the greater SFO Bay area. The rest is sent to LA, Seattle, mid-west and to the east coast”. - Jeff Larkey, Route1 farm, California

One of the reasons for higher local distribution of the produce in Jeff Larkey’s opinion “is increased cost of shipping and more people seeking locally grown produce.” Similarly Full Belly Farm, CA supplies produce through three farmers markets, to restaurants and to wholesalers at weekly basis, year round. The farm also supplies to its CSA 1500 boxes of produce/week, 49 weeks of the year which accounts for one third of Full Belly’s business.



LEARNING FROM A BEE FARMER AT FARMERS MARKET IN PLEASANTON, CALIFORNIA

Examples of success in UA will not be completed without mention of Growing Power (www.growingpower.org) in Milwaukee and Chicago, USA. Will Allen its founder began developing the farming methods and educational programs that are now the hallmark of a successful UA venture which produces and harvests 12 months of the year. Allen’s holistic farming model includes both cultivation and designing food distribution networks. Through a novel synthesis of a variety of low-cost farming technologies – including use of raised beds, aquaculture, vermiculture, and heating greenhouses through composting. Jay Salinas of Growing Power mentioned that they are also well connected to local farms and COOPs to address the 'food desert' issue of the area. He also mentioned that the internships and workshops hosted by Growing Power engage teenagers and young adults in

producing healthy foods for their communities, and provide intensive, hands-on training to those interested in establishing similar farming initiatives in other urban settings.

3.6 Urban Agriculture, Biodiversity Conservation and Ecosystem Services

Urban Agriculture encourages creation of urban plant communities, supporting pollinators including birds and other organisms. It is an effective tool to slow down the loss of biodiversity (Smit, 2000). Avian studies indicate that if declines in some species are to be arrested or reversed, there should be a significant increase in the priority and resources devoted to conservation activities in urban areas (Fuller et al., 2009).

Urban Agriculture provides for important ecosystem services (Davies et al., 2009). For example, bee keeping in urban areas is becoming a critical part of maintaining ecosystem services not just for UA but also for surrounding farms where bees have practically disappeared. Insect pollinated plants make up 1/3 of the diet with industrious bees pollinating 80% of those crops. Farms in these areas are dependent on bees rented for pollination services. In addition to pollination each hive can produce 100 pounds a year if it's properly tended.

"One of the biggest obstacles to urban beekeeping is the perception of bees- that they sting without a good reason". - Feedback from the survey in this research.

Bee keeping is a big movement in San Francisco (sfbee.org), where there are more than a hundred bee keepers. In Vancouver, BC, Canada, the six-acre green roof on the Vancouver Convention Center houses 400,000 indigenous plants and grasses and is home to some 60,000 bees (Cityfarmer, 2009a).

Urban Agriculture enhances biodiversity by continued production of rare varieties of fruits and vegetables, which are adapted to local soils and climate. Small-scale gardeners tend to grow a wider variety of fruits and vegetables than large-scale growers, conserving unique cultivars that might otherwise die out (Garnett, 1996). This increased diversity of urban crops in turn attracts a variety of bird and animal life that would otherwise not thrive in the urban landscape. Urban gardeners contribute to biodiversity conservation when they adopt planting of heirloom varieties and get together into a seed-sharing network.

'Seed saving and community based genetic diversity is an absolute core of the UA.'
- John Bela of sfvictorygardens.org

3.7 Urban Agriculture and Urban Employment

Urban Agriculture can have a positive impact on urban employment. For example in the San Francisco Bay area the League of Urban Gardeners (SLUG) which has membership from some 100 neighborhood gardens all over San Francisco is billed as one of the nation's largest urban-gardening programs. It is also very creative in adding on strong economic-development and job-training components. SLUG provides jobs for over 100 people in San Francisco's industrial Bayshore - Hunter's Point neighborhood. Its \$1.6 million annual budget comes from grants and contracts with the city Recreation and Parks Department to run its 40 urban gardens.

As Nuru and SLUG Youth and Economic Development Coordinator Joshua Bloom mention in the grassroots.org website "Never has the time been so ripe for a national movement helping urban communities to revitalize themselves through gardening. As US Congress threatens cuts to job-training programs and welfare assistance, national and local groups are initiating creative projects which hold enormous potential for reversing economic hardship, social instability and environmental degradation."

Urban Agriculture is now a potential source of employment in Japan (Cityfarmer, 2009b). The Japanese government is set to launch full-scale efforts to promote indoor agricultural facilities on demolished factory sites, unused or abandoned farmland, or even inside vacant stores within shopping districts to ensure stable cultivation of fruits and vegetable to boost the number of indoor growing facilities about fourfold, and raise production about fivefold. The government hopes the measures will make use of idle land and help farming villages affected by the aging population, and in turn, lead to a rise in job opportunities.

In Ohio, USA former urban professional Cameron Anderson who lost his job as a web developer and his wife Denise decided to expand their small farm operation. They teamed up with several neighboring farms to start a CSA which offers monthly boxes of various cuts of meat in full (20 lb.) and half (10 lb.) shares. It also features the innovative "adopt-a-hen" program, in which member families receive 40 dozen eggs, a stewing chicken, and five gallons of henhouse compost over the course of a year (USCUSA, 2009).

3.8 Urban Agriculture and Waste Management

Urban Agriculture can play an important role in municipal waste management (Nelson, 1996). Local production helps close the nutrient cycles associated with human food production and consumption. Instead of putting wastes into landfills, much organic waste can be turned into compost and returned to nearby gardens and farms.

'Cities are an incredible source of fertility which we discard into the oceans and other ecosystems. If we look at historically, how did urban centers develop? Cities provide fertility to grow food. This is being wasted now, I think we must capture it and keep it within the regional system in form of carrying capacity of that region.' - John Bela, of *sfictorygardens.org*

Water reuse in agriculture in the Sydney, Australia is thought to have the potential to save up to 32 billion liters of river water per year (DIPNR, 2004). This coupled with use of biosolids from Sydney's sewage treatment plants has the potential to fulfill the "essence of community ecological management (which) is the principle of closed nutrition" (Smit 2000). Composts are excellent sources of human and plant nutrient that result in the improvement of soil biophysical properties and organic matter levels as well as increased crop yields (CIAS, 1999).

Studies shared by Rich Flammer of Hidden Resources show that in the town of Annapolis Royal, Nova Scotia, to accomplish its zero waste goal, the city has generated 85% participation rate in backyard/neighborhood composting, putting out neighborhood composters for use on streets and multi-family, and giving Green Cones and Earth Machines for individual backyard composting, and providing public drop-off site for yard trimmings. It has successfully diverted 60% of organics waste

into compost.

Composting can come across to people as an environment friendly business venture. However when a facility is planned in the proximity of people's homes or businesses, there's typically an outcry and strong lobby against it. This leads back to the fact that many people are uninformed and don't understand what composting is. Many people don't understand the difference between a professionally-managed compost facility and a landfill. This is where community organized education programs play an important role. Incentives such as lower cost of garbage removal especially in cities that have a PAYT pay-as-you-throw pricing structure will help motivate people to adopt composting mentioned Rich Flammer of Hidden Resources in his email response to the questionnaire sent for this research.

Interviews with composting professionals in San Diego and Santa Clara communities in California indicate that some other challenges in establishing a successful composting programs are the local land use and zoning codes, planners and enforcement agents unfamiliar with the composting process, poorly-run compost facilities that prompt regulators to tighten regulations for the professionally-managed operations, high land values that impede development of facilities in close proximity to areas where the material is generated, and the NIMBY ("Not in my backyard!") dynamic. A decentralized system to produce compost locally is quite feasible, provided it is planned and funded appropriately. Delivery is questionable due to its high cost, but community-based programs can work.

Composting can also receive Carbon offset credits (chicagoclimatex.com). So it is in the best interests of cities to provide adequate funding of programs and to revise rules to promulgate composting, establish good outreach programs and train concerned stakeholders and agencies to understand the connection between composting, resource management, watershed quality, energy, food supply, and public health.

Y.V. Damle, 80, conducts laughter therapy classes for women in East, Mumbai, India. The fees for his efforts is rather interesting - a bag of garbage! This finds its way into plastic bags, drums and laundry baskets on his terrace where he farms for vegetables, fruits and flowers. Like Damle, quite a few Mumbai residents are recycling waste to generate organic farm products right in their apartments. This is not just an effective method of waste management; this form of urban agriculture addresses critical food security issues. Most people are worried about leakage on their terrace floors. But by using compost that problem can be negated, says Anil Ranglani, a city farm enthusiast and promoter of Daily Dump, a product aimed at creating compost at home. It's a bottom up approach where waste is used to produce nutritious products. (Adapted from Mumbai Mirror, April 05, 2009. A taste for waste. By Lekha Menon.)

3.9 Urban Agriculture, Education, Community Relationships and Food Justice

Perhaps the most critical role that UA has to play is in education and building community linkages. As Juneen Schulz, an urban farmer and educator from Australia responded, the biggest challenge in starting an urban farming program in schools is 'recruiting volunteers with interest, a champion person either teacher or volunteer to make the garden successful.'



Milking at Full Belly Farm, Gundia, California, USA

It is also critical to get the “local district involved with other stakeholders such as shop owners, farmers, gardeners etc. These people are able to help with resources and ongoing donations.” In her experience, the biggest lesson for the participants is to understand where food comes from and the different varieties one can grow. Growing food is important to everyone but more so to children to learn life skills that are fast being lost.

It is also extremely important that each child not only grows and nurtures their food gardens but they also need to learn how to prepare their food into a tasty meal to eat. In the Fullcirclefarm in Sunnyvale, CA this is precisely what they do. Middle school children tend their plots in the heart of urban Sunnyvale at the FullcircleFarm and at harvest time they get to cook their food and share with the others.

Educational projects like the Sustaining Ourselves Locally (SOL) farm in Oakland in the Bay area and similar projects can have a significant impact on a few people, or a minor impact on lots of people. To impact many people on a large scale we need many projects, policy change, and a change in our educational and economic system, according to Deepa Iyer from SOL farm.

Alice Waters of Chez Panisse responded in the interview about the importance of such education, either at school backyards or in a restaurant. She mentioned that she envisioned her “restaurant (which uses only locally available ingredients in its dishes), as a place where people can ‘connect the dots’ about food production and use. Chez Panisse was one of the first restaurants to name each farmer and purveyor right on the menu, and the customers can ask their server or host any time about who has grown or produced the food they’re eating.”

According to a WorldWatch Institute study, a typical meal bought from a conventional supermarket chain consumes four to 17 times more petroleum for transport than the same meal using local ingredients. So it helps to have Chez Pannisse type of restaurants that help us connect the dots between production and consumption.

3.10 Energy inputs in Urban Agriculture

Organic farms use much less fossil fuel energy than their conventional counterparts, in many cases as much as one-third less. Organic agriculture can also provide a critical carbon sink, sequestering carbon from the atmosphere. In fact, 10,000 medium-sized organic farms can store as much carbon in the soil as we would save if we took one million cars off the road (from rodaleinstitute.org).

Urban Agriculture which for the most part follows organic methods of cultivation therefore has a small ecological footprint. Its footprint gets even smaller compared to the conventional large scale agriculture when the fossil fuel used in transport the produce, energy used in refrigeration, packing etc are taken into account. This example is best illustrated in the work of MyFarm (myfarmsf.com) a for-profit group which helps their customers garden and compost their food scraps in their backyard to enrich their own gardens, instead of using tractors, this team of gardeners who will set up and work in gardens in San Francisco city for a fee, work by hand and travel by bicycle as much as possible. This reduces the carbon footprint of the produce to a very large extent.

“Fifty percent of the energy is spent between the supermarket and home in the journey of a produce. So closer you can make this link, lesser the energy expended in the process” - Farmer Jeff Larkey of route1farms in California.

A type of UA gaining popularity for its claim of optimal space usage is called the ‘vertical farming’. The Vertical Farm Project (verticalfarm.com) can however be technology and investment heavy and would need more testing before it is established as a clean energy efficient project.

“Vertical farming is an interesting possibility that we should explore and should pursue it and I also think we should prioritize our investments. We should get a good idea of what energy is required to grow a tomato for example in a vertical farm versus tomato grown in a farm connected to earth and to all the other processes. I think we must prioritize protecting peri-urban agricultural lands before investing in new architecture for vertical farming”- John Bela, sfvictorygardens.org

Benjamin Linsley, and Danielle Gould of nysunworks.com shared information about another innovative effort in Abu Dhabi, United Arab Emirates called the GreenMarket Visitors Center. It is designed to integrate a high-efficiency food production greenhouse into the Masdar site office in Abu Dhabi. Masdar City is a planned city in Abu Dhabi that claims to be the world’s first zero-waste, carbon neutral city. It boasts a water-efficient, solar powered, pesticide-free, space efficient greenhouse to be located on the visitors center site. The greenhouse would provide fresh perishable vegetables directly to residents, replacing vegetables that would otherwise be air freighted in from thousands of miles away, and thus radically reducing the carbon footprint of the residents.

A more common and older method of UA that is energy, space and water efficient is the roof top gardens. Egypt embarked on a project to increase the amount of greenery on rooftops. This provided a

good opportunity to increase oxygen production in a choking environment. Green gardens producing food on rooftops have multiple payoff potentials, economic, energy, environmental. Rooftop gardens are efficient in using sunlight and water- both rain and grey water. Berkeley, USA, Vancouver, Canada, and Singapore are some places that are practicing rooftop gardening. Rooftop gardening would have a tremendous impact if the building plan started out with incorporating a roof top garden. It is much easier and economical then since the rain water harvesting, recycling, composting making systems will already be in place.

3.11 Water Management in Urban Agriculture

Grey water from the buildings can be used for cooling green houses set up on rooftops and rainwater harvested can be used for irrigation. Plants suited for local environment should be planted since they will have evolved to seek the available amount of water. In the scenario of climate change of course, it is most prudent to use every drop of rain and grey water. It is critical that new architectural ventures must be equipped with rain and grey water harvesting and use for the gardens.

3.12 Urban Agriculture and Food Safety

One of the issues that were a definite concern for both consumers and producers interviewed through this research project was food safety. More people in this study responded that they may not be comfortable consuming produce grown in public parks or gardens. However the degree of comfort increased if they were to use produce from their own gardens or shared garden in the community. The respondents are not in isolation. Even city's have regulations for produce grown in urban areas and these are more stringent in some areas, as in Toronto, Canada or Pennsylvania, the USA where food safety is taken seriously by the cities. In most cities it is necessary to test the soil before undertaking any edible gardening. However this is not true for many Asian, African and other developing countries, where availability of land outweighs all other parameter of concern to establish an urban farm.

3.12 Urban Agriculture and Policy Changes

Urban Agriculture is such a strong candidate for mitigation and adaptation. Cities that practice UA successfully in as much as a zero waste cycle, the government should recognize and honor such efforts by giving away Carbon offset credits to the city.

To meet this responsibility, Berkeley's Climate Action Plan (berkeleyclimateaction.org) called upon the city to make logical connection between food systems localization and GHG emissions reductions. The Chicago Food Policy Advisory Council - (chicagofoodpolicy.org) is striving to make strides in urban food security through policy changes about public land and open space usage in the cities and adopting edible gardening concepts within the open spaces available in the community, including backyards and public spaces, using rooftops, wall gardening etc. Urban Agriculture has a great potential to change food policies that keep the cost of food at an unnatural low price including trade regulations that encourage food dumping and create artificial food costs add to the environmental and human health costs (Alston, 1999; Vorley and Proctor, 2008). Brahm Ahmadi of Peoples Grocery (peoplesgrocery.org) in Oakland CA said in an interview that partnerships between communities and organizations along with government policies are important to create self-reliant, socially just and

sustainable food system.

Toronto has long been at the forefront of public health initiatives and food security research and was among the first world cities to sign onto, the United Nations' Healthy Cities movement. Some success stories of Toronto Food Policy Council (TFPC) are: Food and Hunger Action- the TFPC wrote and championed the City of Toronto Declaration on Food and Nutrition, 1991; Operational control of the "Field to Table" program was assumed by FoodShare in 1992 and it provides affordable, nourishing, regionally-sourced food to 15,000 people each month; designed Canada's first Food Access Grants Program, approved by Toronto City Council in 1995, and administered the program from 1996 to 1998, directing \$2.4 million for kitchen purchases in 180 schools and social agencies.

There are many possible projects that could have a positive impact on food security and sustainability on a city-wide basis. Some examples include - a city policy that mandates local food sources for businesses that are involved in food, policy on the amount of land under cultivation in the city, and programs to employ people, said Deepa Iyer of SOL in an interview.

3.13 Urban Agriculture and legal and institutional constraints

Urban Agriculture in most cities is a precarious enterprise. Reluctance to change the legal status of Urban Agriculture stems partly from biases against it on the part of urban authorities, and partly from concerns about food safety and the health and environmental impact of UA discussed above. In many cities, agriculture or parts of agriculture like poultry, raising a goat etc are considered illegal. It is here that legal institutions can work with the grassroots organizations trying to promote UA and try to understand the fears and concerns of the other side without prejudice, and reach a consensus.

3.14 The role of local organizations

Role of local organizations is critical in UAs success. For example, in Jamaica, the Ministry of Agriculture launched an Urban Backyard Garden program designed to foster self-sufficiency in food production, to address the spiraling costs of staples, as well as the nation's vulnerabilities to imports (moa.gov, 2008). Over the email interview, Thea Maria Carlson, Program Coordinator of the Urban Initiative at the Angelic Organic Learning Center mentioned that access to land, preferably with long term or permanent tenure, access to safe soil, good quality compost, and water, training in growing and site management skills and marketing and distribution for produce that is grown on the farm are critical factors in UA. Local municipalities, governments and other organizations can play a significant role to address these needs.

CONCLUSION

Urban Agriculture is no longer a romantic option. It is a necessity to address the climate challenge that humanity is facing. Urban Agriculture has a huge advantage in adopting the newer sustainable technologies that are coming down the pipeline as observed by Jay Salinas of Growing Power. Urban agriculture presents our society with a range of opportunities from waste management to food production in a zero waste cycle. Choices that integrate UA into the fabric of urban landscapes have the potential to deliver resilience in economic, social and environmental terms, to reinforce the local

character of place in a global context, and to build sense of place and community.

It is critically important that UA be engaged in its many forms where it is appropriate, with the focus on strengthening community based regional agriculture. With UA we witness a step away from corporate agriculture and a step toward community based regional agriculture.

Urban Agriculture is important for its productive acreage but it is more important from the perspective of transforming urban dwellers from being consumers into a community of co-producers. By participating in UA, people can develop a deeper understanding for food and respect for the farmers who dedicate their lives to growing it. By networking with local farms in 150 mile radius cities can become resilient, powerful by being locally adapted to the regional food system. Cities can move towards zero waste goals by using UA to utilize the organic fertility generated by the city. The 'waste' will be captured and kept within the regional system in form of carrying capacity of the region.

Urban Agriculture is also an economic and social tool which in very simple ways will provide employment opportunities, opportunities for social networking and working together as a community. It will reduce the carbon footprint of city dwellers and decrease their dependence on fossil fuels. "Only by reducing our dependence on fossil fuels and increasing energy production from renewable resources will we start to see improvements and begin to lessen the effects of climate change," NOAA's scientist Pieter Tans said noting that greenhouse gases are on the rise despite global recession (ENS, 2009). This is a sobering observation after all the efforts that have gone into exploring alternatives energy.

Urban Agriculture is a significant tool that if wielded properly, will help us cope with climate change and food insecurity. While search for that is on, we already have an option to reduce our dependence on fossil fuel, by adapting UA. As Mr. Will Allen of Growing Power said (Miner, 2008), "We have to go back to when people shared things and started taking care of each other, that's the only way we will survive." "What better way than to do it with food?"

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