URBAN AGRICULTURE AND HEALTH: ASSESSING RISKS AND OVERSEEING PRACTICES

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Experimental rooftop kitchen garden at AgroParisTech, rue Claude Bernard, Paris (CIPUrA project) - ©Baptiste Gard 2016

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Practiced worldwide for its environmental and social benefits as much as for its food-growing potential, urban and peri-urban agriculture is exposed to various forms of pollution related to cultivation methods and urban air and soil quality, as well as to the varied reactions to pollutants exhibited by different crop types. Faced with this broad spectrum of factors, empirically proven methodological frameworks make it possible to assess health risks and oversee practices in close contact with all actors involved. This is the aim of the work undertaken by teams from AgroParisTech and INRA working on the T4P and REFUGE programs on urban farms in the Paris region, and the Franco-Madagascan ADURAA and QUALISANN programs studying vegetables-growing in Antananarivo, capital of Madagascar.

INTRODUCTION

Urban agriculture projects have been multiplying and diversifying since the turn of the millennium. With all types of solutions varying from aquaponic greenhouses on city rooftops to permaculture, we are witnessing far-reaching alterations in the ways that food is grown. But although the positive impacts of urban agriculture in economic, social, environmental and even nutritional terms are widely reported, it is also vital to look scientifically at the health risks that relate to agricultural production in urban settings. Studies in France and Madagascar highlight specific issues raised in both hemispheres when it comes to defining quality criteria for urban farming and creating the tools needed to support urban agriculture project owners while simultaneously fostering good practices on the part of growers and consumers alike.

POTENTIAL CONTAMINANTS AND CITY-GROWN FOOD

There are numerous factors to take into account when mapping the pollutants to which urban agriculture can be exposed, whether relating to the location where crops are grown, the type of crop, or the characteristics of the soil and pollutants.

POLLUTION SOURCES AND CONTAMINATION VECTORS

A distinction is made between ground-borne and air-borne pollution. The former transfers via the root system whereas the latter involves pollutants absorbed by the parts of the plant that lie above ground level. Water can also be a source of bacteriological or phytosanitary pollution from the use of harmful pesticides, particularly in southern hemisphere countries. Lastly, directly ingesting soil is also a contamination vector.

These distinctions are useful in pinpointing the issues in terms of pollution and growing produce in an urban environment that are specific to developed economies as well as those that apply to emerging economies.

The example of cress-growing in Madagascar, studied as part of the QUALISANN program, is a good illustration of the health issues facing urban agriculture in the southern hemisphere. The risks to city-grown food are mainly bacteriological from residents' wastewater, and are due to the location of production areas in low-lying, flood-prone parts of the city.

In the northern hemisphere, urban agriculture in inner cities and peri-urban areas is developing primarily in short supply chains using methods similar to organic farming, so residual pesticide levels are low. On the other hand, pollution from traffic and in the soil from former industrial uses is a major concern.

SOIL PROPERTIES AND POLLUTANTS

It is also important to differentiate between various types of pollutants, according to their harmfulness and properties when in interaction with their environment. Lead (Pb), for instance, is less mobile than cadmium but it transfers more readily to plants where the soil is acid and low in organic matter. So, the concentration of a pollutant in the soil is simply a partial indicator of pollution risk; another factor is the characteristics of the pollutants and of the soil.

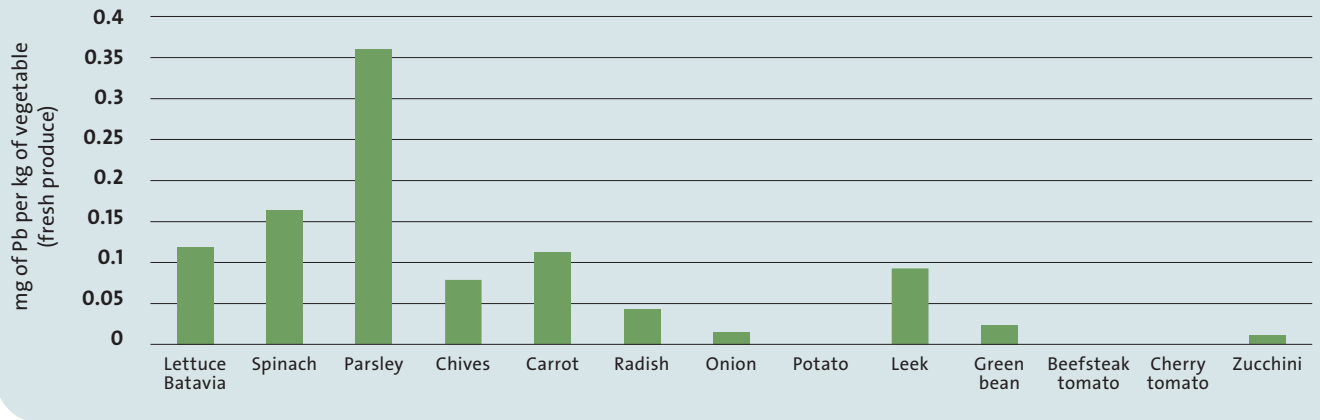
CROP TYPES

Not all crop types are equally sensitive to soil or air pollution. Lead pollution has very little impact on the edibility of fruit, but it does diminish the edibility of some vegetables. For example, leafy vegetables (lettuce, cabbage, spinach, etc.) that have a large area exposed to atmospheric particles, and root vegetables (carrot, radish, beetroot, etc.), are more exposed to risks than fruiting vegetables (tomato, pepper, eggplant, etc.). Certain garden herbs, such as parsley, are heavily exposed to soil and air pollution alike. In urban agriculture, great care must therefore be taken when choosing the location for cultivating such plants. The time it takes for a crop to grow is another consideration. The longer a plant is in the soil, the more it is at risk of being impacted by a range of pollutants; for example, this means that thyme, which is exposed year-round, is more sensitive to pollutants than basil.

URBAN AGRICULTURE MODELS

The type of urban agriculture also plays a not inconsiderable role in cutting or increasing some risks. Indoor urban agriculture, for example, will naturally tend to minimize the risk of air or soil pollution. But this model of farming raises other issues that relate to the amount of energy consumed, the profitability of the crops – in the light of the financial investment needed – or the artificial nature of such growing systems, which sometimes struggle to be accepted by consumers who are wary of wholly artificial local production systems.

Example of results analyzing lead (Pb) concentrations in vegetables grown in contaminated soil



ASSESSING HEALTH RISKS: MEASUREMENTS AND TOOLS

MEASURING POLLUTION IN URBAN AGRICULTURE: CASE STUDIES

In recent years several research projects and experiments have set out to measure the healthiness of urban produce at the local level.

T4P, which began in 2012, is a project run by a team of researchers from AgroParisTech and INRA. It aims to assess the feasibility and safety from a health standpoint of food grown on rooftops. Ten vegetable plots were selected from the 367 hectares of urban agriculture projects in the Paris region. Installed on rooftops of various heights and with varying nearby traffic levels, they permit a comparative analysis of the degree of pollution. Four of them are located on suburban shopping malls, in Porte de Versailles, Vélizy-Villacoublay, La Défense and Levallois-Perret; four others are on the roofs of buildings occupied by public transportation operator RATP. An experimental vegetable garden has also been established on the roof of AgroParisTech *(see photo below)*. The last site examined is on the roof of a Carrefour supermarket in Villiers-en-Bière. The results obtained so far are very encouraging. At only one site, where there are kitchen herbs that are especially sensitive to pollutants, were the EU's health norms exceeded. At all the other sites, concentrations of trace metals (cadmium, lead, arsenic, nickel) are 3 to 5 times lower than the European regulatory thresholds.

The study also measured pollution caused by highly carcinogenic polycyclic aromatic hydrocarbons (PAH) from wood stoves and road traffic. At the time of writing, the 45 vegetable samples analyzed exhibited concentrations of the most dangerous PAH in levels below the minimum regulatory thresholds set by the European Commission.

This means that in a city like Paris, once beyond a certain distance from major thoroughfares and above a certain height for growing (roughly speaking above the 3rd or 4th floor), the concentration of pollutants diminishes drastically; this means that vegetable crops grown there are generally harmless to eat.

In emerging economies, city-grown crops often face an accumulation of risks. The cress grown in Antananarivo is a good example and has been studied by a multi-disciplinary Franco-Madagascan research team of agronomists, chemists, economists, geographers, microbiologists and nutritionists since the early 2000s[1]. This work has highlighted the inherent risks relating to geographical location and the ways that cress is cultivated and sold. The capital of Madagascar presents health risks at every stage of the chain. Upstream, the topography of the cress-growing locations presents an initial risk factor as these are often close to major roads or housing, with the wastewater discharges this entails. In terms of the way the cress is cultivated, there is clear evidence of excessive use of pesticides, herbicides and fertilizers. Lastly, there are also risks engendered by the sales method: produce is not sorted or washed prior to sale, cars used for transportation are rarely cleaned and stallholders frequently rinse cress in dirty water because drinking water has to be purchased from standpipes.

Irrespective of the public health challenges, the food-growing role of urban agriculture remains central in southern hemisphere countries where the majority of fresh produce (vegetables, eggs, milk, etc.) is sourced from the city or its immediate environs.

REFUGE: A METHODOLOGICAL TOOL

REFUGE (urban farm risks: management and assessment) is a participative research program set up in 2016 by a research team from INRA and funded partly by AgroParisTech, then by ADEME (the French environment agency) and the Île-de-France Regional Council. It aims to develop an empirically proven methodological framework for assessing the health risks of urban agriculture. As part of a more wide-ranging study into how Paris's city farms operate, the REFUGE methodology is designed to assess and manage health risks relating to the presence of trace metals in soils and, more recently, total concentrations of PAH and hydrocarbons. It relies on twin complementary approaches, each the result of two years of experiments at micro-farms.

The first component seeks to describe existing forms of soil or air pollution using a range of techniques inspired by methods used by ADEME in its polluted sites and soils programs, which include soil analysis, study of the physicochemical structure, and drafting exposure scenarios for people likely to visit the site. These analyses are intended to make risks easier to interpret and are useful as decision-support tools. The diagnosis is nuanced in most cases. It is rare to encounter a configuration where pollution is inexistent or omnipresent and in most cases the reality lies somewhere between the two. Taking this as a starting point, it is then necessary to multiply the number of categories to take account of all possible situations: carrying out quantitative regression analysis of health risks, analyzing test vegetable samples, etc.

The second component of REFUGE is designed to improve management of previously identified risks through adoption of a health control plan. Health control plans are grounded in regulations that apply to conventional agriculture and use well-known risk management methods such as HACCP[2] (Hazard Analysis Critical Control Point). Health control plans include a set of good farming and food hygiene practices to adopt in order to improve risk management, including carrying out regular soil contamination analyses, preventive measures to guard against air-borne soil (wearing masks and gloves, careful watering), and performing tests on certain specific types of vegetables.

1 Work carried out as part of CORUS ADURAA (analysis of the sustainability of agriculture in the Antananarivo agglomeration) from 2002 to 2007, QUALISANN from 2007 to 2010, and LEGENDE, a current project run by CIRAD and INRA.

2 Introduced into the EU in 1993 by Council Directive 93/43/EEC on the hygiene of foodstuffs, HACCP is based on the following principles: identifying, assessing and describing the control points.

The REFUGE methodology is designed to be used by a range of different actors. The first of the project's components focuses primarily on municipalities, seeking to give them the tools they need to grasp the nature of risks that can be a problem for some plots used for urban farming, and to ensure that sampling takes place under the right conditions. Once they are better informed and aware of what is needed, municipalities can, where necessary, approach a consultancy with expertise in polluted sites and soil to provide them with a legally binding site appraisal. Health control plans are designed more to help in the implementation of urban agriculture projects by businesses or private individuals. In time, it is also possible and desirable for the ministry of agriculture to become involved in the nationwide promotion of health control plans for urban agriculture.

It is imperative to involve all actors in building a healthy urban agriculture activity, first of all by making sure that they know the risks

RECOMMENDATIONS AND OUTLOOK

It is possible to list several recommendations for improving the food safety of urban agriculture and, in a more general sense, for helping to drive its growth.

First of all it is vital to focus on crops that are best suited to this form of cultivation, and on developing products that complement, rather than compete with, conventional agricultural products. For instance, it is better to focus on growing produce with high added value, such as micro greens, mushrooms or exotics that might benefit from urban heat islands. It is important to remember that urban agriculture is less about growing large volumes and more about growing locally and offering innovative crops, at least in industrialized countries.

Next, it is imperative to involve all actors – municipalities, businesses, farmers and residents – in building a healthy urban agriculture activity, first of all by making sure that they know the risks.

In southern hemisphere countries, local people are relatively aware of the problem of bacteriological pollution. In Antananarivo people eat cress cooked, not raw, because locals place greater importance on food safety than on a lower nutritional value. But quality criteria for foodstuffs from urban agriculture in the southern hemisphere are generally yet to be fixed, and not all actors in the chain from producer to consumer are equally aware of the health risks. There are also other concerns that have to be addressed, particularly the health of farmers exposed to pollutants and the impacts of excessive pesticide use on biodiversity.

The situation in northern hemisphere countries is more contrasted. In France, municipalities' position on the subject of urban agriculture varies from the overly cautious, tending to overlook the benefits, to the majority that simply knows little about it, and are hampered by a lack of resources. Mirroring this are consumers, who also show varying degrees of awareness and mobilization. Although it appears that there is some concern about artificial cultivation systems, produce grown by urban agriculture is still hardly ever spotted on supermarket shelves, making it difficult to draw any conclusions at this stage.

There is also the question of providing appropriate tools for helping with risk management. It would be a good idea, for example, to bring together soil analyses and the monitoring of vegetables to make oversight of an urban agriculture project easier; currently, consultants tend to specialize in one field only. In the same vein, a digital version of the health control plan will soon be available and distributed as widely as possible to people and bodies involved in running urban agriculture projects. Working through its regional network of DRIEA offices, the French ministry of agriculture is incrementally adopting positions on these issues, which means it is vital that urban agriculture respects the same food safety standards for the use of contaminants and pollutants that apply to conventional agriculture. This will require new legislation in the future.

CONCLUSION

Maximizing the benefits of the potential offered by urban and peri-urban agriculture in economic, social, environmental as well as nutritional terms demands efforts both to improve understanding of the risks and to improve practices. This twofold challenge shows that greater collaboration between researchers, project owners and public authorities is more important than it has ever been.

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