African urbanisation trends and implications for urban agriculture

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– Challenges and Knowledge Gaps

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Editors: **Ulf Magnusson** and **Kristin Follis Bergman**

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– CHALLENGES AND KNOWLEDGE GAPS

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Introduction to urban and peri-urban agriculture for food security

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By 2050 the UN estimates that the global population will reach 9.6 billion, with the majority of that growth taking place in urban areas of less developed regions (United Nations, 2012; United Nations, 2013). Sub-Saharan Africa in particular constitutes a great portion of that growth as the urban population expands faster than any other region and is projected to double between 2010 and 2030 (FAO, 2012). The rapid expansion of urban populations puts direct pressure on food sources and agricultural production; thus, there exists a serious challenge in supplying enough nutritious and safe food amongst such rapid urbanization.

Despite many technological and mechanical improvements in food production, hunger and malnutrition remain central issues as poverty continues to be prevalent in many cities around the world. Specifically, it is estimated that 40% of urban inhabitants are living on less than US$1 a day, while simultaneously 70% are living on US$2 a day (FAO, 2012). Similarly, impoverished urban households are estimated to spend 60–80 percent of incomes on food, making them more vulnerable to food price volatility (Baiphethi & Jacobs, 2009; Cohen & Garrett, 2010). Rapid urbanization has produced a large group of urban poor, proliferating widespread issues like food insecurity and malnutrition in the developing world.

Rural dwellers moving to cities often bring their agricultural practices with them for food security and livelihood reasons (Thys et al., 2005). This transformation of agriculture from a traditional rural industry to an urban and peri-urban phenomenon has led to significant displays of livelihood changes. There is not yet a universal definition on urban and peri-urban agriculture (UPA). Here, it is referred to as agriculture practices, formal or informal, within and around cities, which raises, processes and distributes food from fisheries, horticulture and livestock. Some years ago a conservative estimate was that 15–20% of world's food was produced in cities (Armar-Klemasu, 2000).

Urban and peri-urban agriculture is used as a strategy by many urban dwellers to improve their livelihoods and overall well-being. Firstly, UPA improves a household's access to food during times of shortage, instability or uncertainty (Bush, 2010; Zezza & Tasciotti, 2010). Secondly, UPA can act as an income generating activity as farmers produce for markets or sell surplus, which contributes to a household's income security (Cohen & Garrett, 2010; Mougeot, 2005). Lastly, UPA contributes to improved health among the urban population by providing highly nutritious and fresh foods (Zezza & Tasciotti, 2010).

Despite these positive aspects of food security, livelihoods and access to nutritional foods, there are downsides to UPA. Some major problems are the increased risk for the spread of diseases from animals to humans as well as sanitary and environmental problems related to waste, water and manure (Bonfoh, et al., 2010; Menzi et al., 2010).

The major challenge with UPA in low-income countries as a driver for positive human development is to balance the pros and cons by wise regulations and incentives. Here we contribute to this policy discussion by a comprehensive and multidisciplinary overview of current scientific scholarship of several themes within UPA, with a focus on sub-Saharan African conditions. Each chapter gives an overview of the topic, insights into trends, opportunities and challenges, and finally knowledge gaps within the ever-growing field of UPA.

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African urbanisation trends and implications for urban agriculture

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Two events in 2008 together marked a tipping point that came to temporarily redirect the traditionally rural (and agrarian) gaze on food security towards urban areas. While the global food price crisis and the protests it sparked in a number of cities across the world pointed to the vulnerability of the urban poor, the fact that the global urban population surpassed the rural one for the first time in the history of the planet (Satterthwaite, McGranahan, & Tacoli, 2010) underscored the possibility that also future food security concerns would take on an increasingly urban slant.

TRENDS

In sub-Saharan Africa, these events have been tied to alarmist notions of "unprecedented levels" of urban growth widely perceived to be connected to rapid in-migration from rural areas as well as "growthless" and jobless urbanization (Fay & Opal, 2000; White, Mberu, & Collinson, 2008). In this characterization of events, the combination of a rapidly growing urban population, stagnant domestic agriculture and rising global food prices make for an explosive future. While this scenario clearly suggests a profound social, political and economic crisis, the demographic statistics used to underpin this type of analysis are at best flawed, and at worst entirely lacking. While the future challenges of urban growth in Africa should not be downplayed, the possibilities for dealing with such challenges in some respects rest on grasping what's going on rather than relying on presumptions made in policy based writing, often tied to particular political agendas.

So what do we know about urban growth in Africa and what can this knowledge tell us about the future? The answer to this query is more complex than its deceptively simple formulation would lead us to suggest. However, before outlining the potential trends of African urbanisation, a couple of statistical pointers are necessary. Although migration as a source of urbanization tends to receive the largest amount of attention, especially in policy related writing, urban growth in statistical and demographic terms is connected to three types of changes. Firstly, natural population growth in urban areas occurs as a result of differences in fertility and mortality rates among existing urban residents. Secondly, migration from rural to urban areas redistributes people away from the countryside to towns and cities. Finally, statistical re-classification of rural areas and the physical expansion of urban areas lead to boundary transformations that change the status of rural residents to urban dwellers. In these cases, areas are graduating from a rural to urban status as population thresholds and definitions of "urban" are crossed. When the urban population growth rate is higher than the rural one, this leads to an increasing share of the urban population over time and urbanization occurs.

However, the relative importance of the components of urban growth varies over time. Due to the use of demographic models that rely on past trends to predict the future, historical patterns of urban growth are strongly reflected in the prognostications made for future growth. The widespread lack of census data in many African countries means that population estimates, rather than actual population data, have often been used to depict the present as well as predict the future. The politics tied to urban classification have in some countries made the collecting of urban census data controversial as well as problematic (Potts, 2012a; Satterthwaite, 2010). The lack of a common global definition of what exactly constitutes an urban settlement adds further complications to existing datasets. Despite these difficulties, most cross-country comparisons of urbanization levels are based on the United Nations Population Division's World Urbanization Prospects circulated since the 1970s. The baselines for the Prospects are taken from census data or national population estimates and are used to calculate population projections, including shares of rural and urban populations. Compared with the few other globally comparable datasets that exist, for instance the work of Global Rural-Urban Mapping Project (GRUMP) (Balk, Brickman, Anderson, Pozzi, & Yetman, 2005) and the World Bank's agglomeration index (World Bank, 2009), the figure for the urban share of the population for sub-Saharan Africa (37% in 2010) in the World Urbanization Prospects is considered to be slightly overestimated.

Gloomy notions of rapid urbanization can, in some respects, be explained by projections of urban growth that are now widely considered to have been exaggerated. In turn, the explanation for such overestimation can be sought in the relative importance of migration versus natural growth in the processes of African urbanization since the 1960s. Urban growth in colonial Africa was limited through mobility controls on the African population in many settler colonies. Alongside considerable public investments in the capital cities of the newly independent countries, the scrapping of such controls came to encourage rural to urban migration in the 1960s and 1970s (Potts, 2012b). Migration as a source of urbanization has affected not only projections of future urban growth, but also the popular image of African urbanization. The inability to provide employment for incoming migrants and the notion that rural poverty is driving urbanization means that African urbanization is often seen as a symptom of rural poverty as well as a cause of urban despair (Todaro, 1997).

These views are increasingly questioned not so much in relation to the characteristics of African urbanization, but rather in relation to demographic trends and the relative influence of the different components of urban growth. While it is important to note that African urban areas are growing (and will continue to do so), the speed of that growth has fallen from the

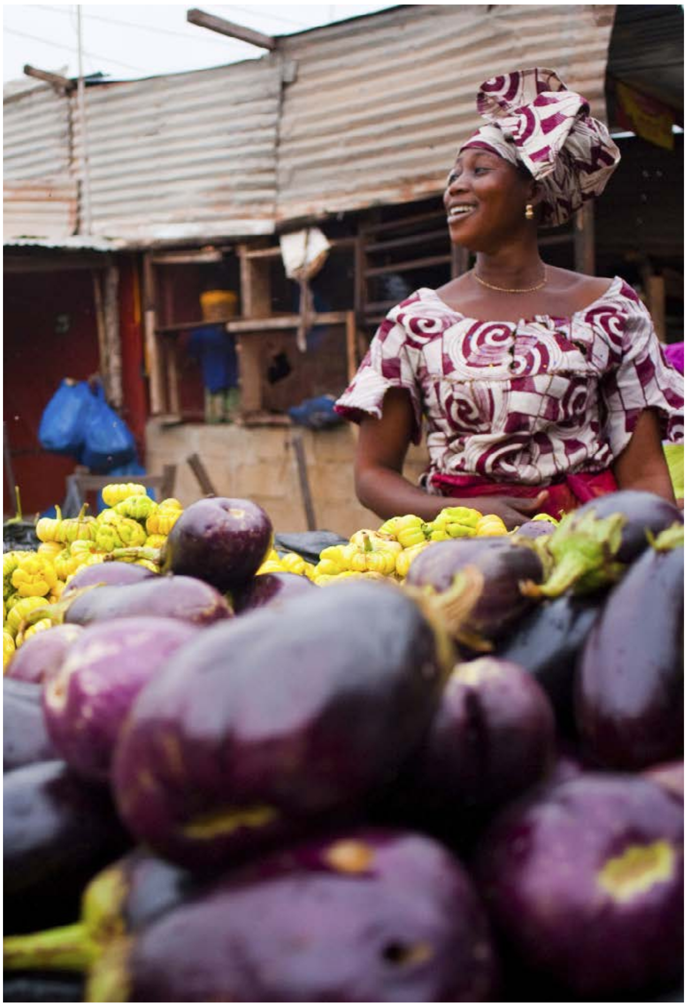
1980s onwards and, according to the World Urbanization Prospects, was 4.1% per annum for the first decade of the 2000s (United Nations, 2012). Falling urban growth rates in the 1980s and 1990s are confirmed by a number of authors; additionally, more recent examples of counter-urbanization – that is a shrinking share of urban population in the total population – has been noted in some countries (Beauchemin & Bocquier, 2004; Potts, 2005, 2009).

Meanwhile, the importance of various components of urban growth has shifted, away from rural to urban migration towards natural increase. While 40% of urban growth was attributed to migration in the two post-independence decades (Tacoli, 2001), in the 1980s, natural increase accounted for 75% of urban growth according to a report from the UN (Chen, Valente, & Zlotnik, 1998). The change in the relative importance of migration versus natural growth is explained by rising urban poverty rates and the closing of the rural-urban income gap. As differences in urban and rural incomes are levelled, and urban livelihoods become more precarious, migrants are voting with their feet and more permanent migration is increasingly replaced by circular, seasonal migration or even return migration as a way of dealing with urban insecurity (Mabogunje, 2007; Potts, 2009).

While migration from rural to urban areas is declining, another source of slower urban growth is falling natural increase in urban areas, with decreasing fertility rates noted in a number of African cities in the 1980s and 1990s (Beauchemin & Bocquier, 2004) as well as more recently (Potts, 2009, 2012a, 2012b).

Urbanization patterns are also increasingly focused on larger urban settlements, which have experienced more rapid urban growth since the early 2000s when compared with smaller towns. However, the majority (54.6%) of urbanites in Africa still live in settlements with fewer than 500 000 residents (United Nations, 2012).

Given the slowing of urbanization, Africa is likely to be a predominantly rural place in terms of its population distribution in the next few decades, while the brunt of the urban population will gradually be found in larger urban centres. More importantly, however, urban population growth, which is less rapid than often assumed, is distinctive on at least two accounts: it is much less accompanied by falls in poverty rates (whether rural or urban) and improved incomes (than seen in Asia for instance); and, it is characterized by strong ties to rural areas as a means of counteracting insecure urban livelihoods.



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OPPORTUNITIES

Urbanization elsewhere has been accompanied by significant dietary shifts, both as a result of changing dietary preferences as well as changing gender roles in association with the need for earning two incomes in urban areas (Popkin, 1999). In turn, this has created niche markets for high value products such as meat, dairy, fresh fruits and vegetables as urban incomes have improved.

CHALLENGES/OBSTACLES

Hypothetically, markets for high value perishable goods produced in and around urban areas could be one result of urban growth, but the depth of such markets also depends on urban incomes and, not just population growth rates. While Asian urbanization processes generally have been accompanied by rapid improvements in poverty rates, this has not been the case in Africa (Ravallion, Chen, & Sangraula, 2007). This difference means that there are less grounds for optimism in the African case as the type of agriculture practiced in urban areas may be focused largely on subsistence rather than commercialization. This can be related to lacking markets (weak consumer demand because of low incomes), but it may also be tied to urban agriculturalists growing their own produce to avoid buying food in increasingly globalised markets.

In the context of livelihoods characterized both by rural as well as urban insecurity—tied to the vagaries of employment, markets and climate—the reliance on kin relations to compensate for such vulnerability also points to a potentially distinctive role for urban agriculture in Africa. The crucial role of food transfers from rural relatives to urban areas to achieve food secure urban households has been noted by several researchers (Andersson Djurfeldt, 2012; Frayne, 2010). While such transfers are critical to the urban poor especially, they do however have the effect of undermining potential markets for food produced in urban and peri-urban settings. Hence the demand for goods produced by urban agriculturalists may be restricted by generally low incomes as well as food transferred through family networks. In this context, it should be noted that there is little knowledge of food moving in the other direction, from urban to rural areas. To the extent that this transfer of food does exist, surplus production from urban agriculture, which under other circumstances could have been used for sale, may be directed towards feeding relatives in rural areas.

KNOWLEDGE GAPS

While a general lack of knowledge in relation to urban agriculture is often noted in literature, more specific gaps can also be identified. Understanding the importance of urban agriculture as a source of income and how this varies by gender, wealth and area of residence, is one such gap. The relative importance of subsistence based production versus commercial urban agriculture is another. In turn, this has implications for what kind of policy priorities are relevant to the sector, for instance in relation to crop science, livestock interventions, marketing structures and food safety interventions in connection with end consumers. If urban agriculture is practiced primarily to raise incomes through the sale of products to other urban residents, the policy priorities need to be quite different from subsistence based urban agriculture.

Urban agriculture also needs to be placed in the context of the food security portfolios of the poor especially. Documenting the share of home grown food in relation to other sources of food, whether bought or transferred from rural relatives, is clearly crucial in designing interventions aimed at improving urban food security or programmes that target vulnerable households.

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PHOTO: MALIN PLANTING

Economic drivers for urban and peri-urban agriculture

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The main task of economics as a discipline in this context is to seek drivers and inhibitors explaining urban and peri-urban agriculture (UPA). This requires evaluation of the behavioural characteristics of farmers and of some of the characteristics of the UPA system as a whole (with adequate system boundaries).

Urban and peri-urban agriculture (UPA) is a social phenomenon in time and space; an economist's analysis of this phenomenon can fruitfully start with an equilibrium analysis. In economics, an equilibrium distribution (number, size, and type of production) of UPA would exist relative to other types of farming (if prices were similar enough from urban to peri-urban, to rural) so that nobody can make money from moving production from one size or location to another. In such an equilibrium analysis, economics assumes that farmers do not need to know or consider the functioning of the whole economy. Instead, they need to know the prices of their inputs and outputs, the prices they can receive for different qualities of production, the relative prices of inputs, the net earnings that would be obtainable if they shifted from one type of production to another, the characteristics of their farm land, or what the net earnings would be if they left farming and took the best job for which they are qualified. No farmer can know if there are too few or too many other farmers exploring other ventures, or whether s/he produces too much or too little – these activities seem to become dynamically coordinated through the market mechanism, allowing the farmer to act upon price signals as beacons. A central idea in economics is that the measure of how well farmers accomplish what they would like to accomplish depends on what others (adequately selected as benchmarks) are doing.

Hence, the equilibrium is a result that can be analysed with respect to its inherent qualitative properties, i.e. what do we get out of it? The question is not how many farmers would like to exit or enter UPA when they become acquainted with what other UPA farmers are doing and what other alternatives exist; rather, the interesting and difficult question is whether some altogether different farming arrangement might better serve the purposes of many or most of these farmers. Most importantly, the analysis focuses on how satisfactory the construction of UPA is, as collectively created by UPA farmers, and not on how well each farmer is adapting to the existence of UPA. In so doing, economics as a discipline, in contrast to other social sciences, is concerned with exchanges and transactions in which everybody affected is a voluntary participant. Such exchanges and transactions are then assumed not to have major implications for those who do not participate in the exchange and who are not in a position to veto it.

Among the factors that make a free market work are physical protection, contract enforcement, contractual rights (including tenancy, or land titles) and other legal arrangements, and standardisation of products (including a shared terminology for describing key elements). It is also well-known that there are plenty of factors which work to inhibit the functioning of a free market. Such aspects include: lack of knowledge; large entry and exit costs related to investment and financing; lack of information on price and quality; ignorance of risks and uncertainties; and lack of official monitoring and control. All of those aspects that make the free market fail to work are, of course, also the primary aspects that make the market actually work (and thus able to establish equilibrium).

The following sections aim to identify trends, opportunities, challenges/obstacles and finally some knowledge gaps of relevance for how satisfactory a collectively created UPA system is for farmers themselves.

TRENDS

With cities in the developing world growing rapidly, farming in and around urban areas is expected to play a greater role in feeding urban populations. Through its proximity to local markets, UPA is expected to become increasingly important for food supply and nutrition, particularly of perishable produce, to the approximately 700 million urban residents already living in developing countries.

UPA is expected to be even more important in the future, as most of the growth in global population between now and 2030 will be concentrated in the urban areas of developing countries (FAO, 2010). World-wide, UPA involves some 800 million people (Midmore & Jansen, 2003) and generates significant livelihood opportunities, not only for urban and peri-urban farmers, but also for traders, input suppliers and other service providers along the value chain for domestic produce (Scott et al., 2004).

Fresh produce retailing in most developing countries has, until recently, largely been limited to on-farm and wet (open-air and roadside) markets. However, the past decade has witnessed the emergence and rapid growth of non-traditional outlets (supermarkets and specialist stores) for retailing fresh vegetables in some of these countries (Minten & Reardon, 2008; Neven & Reardon, 2004). Despite the changing nature of fresh produce retailing, however, the traditional markets still serve the majority of urban consumers in developing countries (Tshirley and Ayieko, 2008). In Kenya, for instance, more than 90% of fresh vegetable purchases are made through traditional retail outlets (Tshirley and Ayieko, 2008).

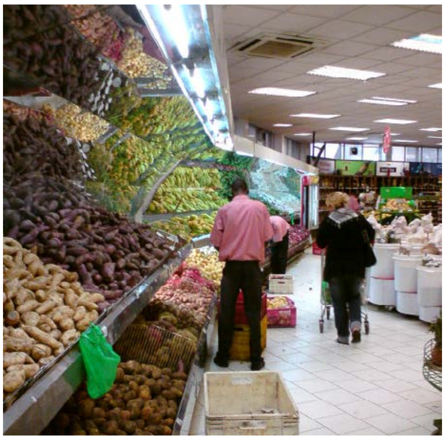

PHOTO: CARL JOHAN LAGERKVIST

The increase in demand for fresh produce at non-traditional outlets is being driven by a number of factors. First, higher income (which translates into higher purchasing power) in the urban centres of many developing countries has made consumers more discriminatory about the quality and source of their food (e.g. Reardon et al, 2001). These consumers thus source their supplies from outlets they consider safe or perceive to offer quality food. Second, there is an increased awareness among developing country, urban consumers concerning the health dangers of consuming foods grown using unsafe practices (Lagerkvist et al., 2013a). Third, there is general belief among consumers that fresh produce sold through certain outlets (e.g. supermarkets and specialist stores) is produced using safer production practices (Lagerkvist et al., 2013a).

OPPORTUNITIES

It is well documented that UPA is undertaken by farmers for three reasons: cash (mainly vegetables and livestock); food subsistence (including savings on food expenditure); and as a survival or risk buffering strategy (e.g. Armar-Klemesu & Maxwell, 2000; Nugent, 2001). Hence, any analysis of the creation of UPA needs to consider which of these aspects is most decisive for the development of UPA, or whether and how all three aspects should be analysed together. UPA is mainly recognised for its multi-functional role, but adequately feeding a large urban population may require further focus on how this can be done in the most efficient way. Consequently, to allow for efficient use of resources in the economy, greater focus should be on whether and how UPA can be an economically viable option for society, rather than on its subsistence role, as it is probably possible to make other arrangements for how UPA can function in that sense. It might be wise to disentangle these multiple roles and allow UPA to be a separate system. Attention should be given to the societal efficiency of UPA as a source of food and service supply within food value chains, with a comparison to the other options that exist for such food chains to source their products.

A further focus on viable UPA from a business perspective may carry over to considering how UPA could grow out of its small-scale character. In doing so, careful consideration should be given on how to change the mindset of farmers so that they focus on income opportunities instead of self-subsistence. This is likely a societal aspect that will require stimulation of entrepreneurship and better personal attitudes to adopting a business orientation.

The growing urban population and changing income distribution through economic development provides opportunities for business development of UPA. Fresh vegetable and livestock products have short marketing chains due to their perishable nature. This means that UPA by its proximity to local markets could have a competitive advantage over produce sourced from more remote locations. Farmers and value chain actors need to position their products, prices, promotions and sales channels so as to maximise the market potential. Furthermore, policy makers could be made more aware of the societal benefits of UPA in securing access to fresh and nutritious food. The attitude of policy makers in just tolerating UPA (De Bon et al., 2010), rather than encouraging it, also needs to change.

CHALLENGES/OBSTACLES

There are various challenges and obstacles to the development of economically efficient and viable UPA to supply food and services:

Increasing urban population growth means increasing competition for land (with alternative uses for housing and infrastructure needs), which can be expected to increase the (opportunity) costs of land. Hence, inefficient UPA will face legitimate pressure for crowding out land (Ellis and Sumberg, 1998). This pressure is already apparent through restricted access such as short tenure contracts or other aspects of tenure insecurity. This aspect is more daunting for UPA that is motivated for reasons of subsistence or risk buffering. Increasing opportunity costs of land also means that UPA as a viable business venture needs to be increasingly profitable to secure its position or, alternatively, relocate to more remote areas.

Access to water is essential for all UPA, but water is becoming increasingly scare and more costly, reducing the competiveness of UPA. To overcome this, there is widespread use of sewage water for irrigation as well as low-cost fertiliser, which poses health risks to farmers and consumers. These problems are likely to escalate with increasing population density and lack of proper infrastructure for fresh water. Systems for rainwater storage are not widespread and water reuse, as integrated resource use, is not currently being explored (or is prohibitively costly).

Current farming, handling and transportation practices are not safe. During production and handling use of poor quality water, heavy use of pesticides and non-judicious application of fertiliser affect the safety of vegetables to an extent that raises concerns about public health (Karanja et al., 2012; Kutto et al., 2011). Current practices also cause soil degradation and pose other negative environmental effects. Although farmers have been found to be largely aware of the risks to themselves and others by their unsafe practices (Lagerkvist et al., 2012; Okello et al., 2013), there is little incentive or enforcement to change. This generates inertia and, together with consumer mistrust and uncertainty, dilutes the competiveness of UPA.

The existence of traditional and non-traditional market outlets has partly generated an illusion of access to higher quality and safer food. Consumers at both traditional and non-traditional market outlets are willing to pay (WTP) premiums for purchasing safer food (Lagerkvist et al., 2013b) for reasons of disease avoidance. Furthermore, food handling conditions at supermarkets or high-end markets are perceived by their customers as providing safer and higher quality vegetables than traditional markets. However, this perception is not supported by studies measuring objective food health risks. A recent study by Kutto et al. (2011) in Nairobi showed that post-harvest handling and retailing practices were the major contributors to microbiological contamination of fresh vegetables. They found that the prevalence of pathogens was higher in traditional markets than high-end markets. However, the prevalence of E. coli was as high as 20 per cent even in high-end markets, posing a significant health risk to consumers. This illusion of safety indicates the presence of a market failure.

Can we expect UPA to produce high-quality products in highly populated areas within a polluted environment, where inadequate water management and wastewater discharges exist? The answer is probably why not? Otherwise, UPA for cash purposes should be relocated to places where such requirements can be met. Consumers at traditional markets, although perceive their food to be less risky than that at non-traditional outlets (Lagerkvist et al., 2013a), are still willing to pay to get access to safer food. While there will probably always be people with little purchasing power, and hence potential buyers of inexpensive (and risky) food, the long-term costs to society of sustaining current unsafe practices are excessive.

UPA has, in many countries, not been adequately regulated. In countries where it is regulated, the enforcement of food quality and safety requirements along value chains has often not been efficient. This has impeded the development of viable business models.

Value chains for fresh produce supplied by UPA are in many contexts inefficient. This is due to high transaction costs (i.e. frictions related to voluntary exchanges and transaction) and rigid price transmissions (related to how relative prices are formed and influenced in between the markets for UPA produce and the relations to wider domestic or export markets). Such distortions are due to: lack of knowledge to identify viable alternatives to current practices and actions; large entry and exit costs due to costs related to investment and financing; inappropriate transportation and storage facilities; lack of asymmetric or misinterpreted information related to prices and quality signals; inappropriate contractual arrangement by use of monopoly power by wholesalers and retailers; ignorance of risks and uncertainties; and lack of control, verification and enforcement of compliance with contracts, standards, institutions and regulations. Hence, farmers face problems in taking economic advantage of their proximity to markets.

How competitive will UPA be in the future as a source of quality and safe fresh produce, as income distribution continues to shift due to economic development? This aspect should consider that product and process quality and safety typically represent intrinsic and credence aspects (i.e. product features that cannot be observed by the consumer even after consumption). Establishment of trust and accountability is central if consumers are to believe in, and actively seek, such produce. Measures along the whole value chain need to develop and transparent information should be provided to consumers (and other actors who decide which products to choose).

KNOWLEDGE GAPS

The aforementioned challenges and obstacles matter because they relate to the extent motives and underlying needs that drive those people that represent 'farmers' to the point of UPA 'for cash' phenomenon. However, UPA as a collective creation will not have an inherent objective per se, for example in addressing urban food insecurity problems. This is a potential consequence of UPA systems that needs to be addressed accordingly.

There has been extensive research on the economic impact of UPA and a vast body of literature that seeks to explain small-scale involvement of people from low-income countries. However, neither impact nor focus on subsistence and risk mitigation is sufficient when seeking to understand how and why UPA can be a sustainable source of food and nutrition to growing urban populations. The World Economic Forum currently ranks food security third among the global risks with the worst impact (WEF, 2012). Hence, more research is warranted to explore the relationship between behavioural characteristics of farmers and the characteristics of aggregated UPA (for cash) systems. However, the aggregate is perhaps not only an extrapolation from the individual, since there are situations in which the behaviour or choices of UPA farmers depends on the choices of other farmers (or the functioning of domestic and export markets). Such situations do not allow any simple summation to the aggregate. We have to look further at the interaction between individuals and their environment, such as the economic organisations of value chains for fresh produce. How well a UPA farmer does for himself in adapting to his social environment is not the same thing as how satisfactory a social environment is that they collectively create for themselves.

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Gender dimensions of urban and peri-urban agriculture in sub-Saharan Africa

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Studying gender within urban and peri-urban agriculture (UPA) is difficult because gender does not pertain only to single livelihood strategies, but permeates most aspects of social life. In order to understand gendered divisions within urban food production, it is therefore important to place farming in a larger context of social relations, including norms and values. It is also crucial to study UPA holistically, as a system consisting of inputs, outputs and different production stages as well as determine how sexual difference intersects with every aspect in a way that currently results in women's continuous marginalisation.

As a research topic, gender and UPA is commonly being portrayed as in dire need of scholarly attention. Although there are still considerable knowledge gaps, the past ten years have nevertheless seen a growing body of literature specifically targeting differences between men and women in urban food production. An important contribution to the field is the book "Women Feeding Cities" (Hovorka et al.), published in 2009, which describes women's conditions within UPA from a range of different settings all over the world. Larger publications on UPA generally include, if not a chapter then at least a section, on gender; there has also been a substantial growth in academic papers from the beginning of the 2000s and onwards.

There is no question that UPA as a livelihood practice is characterised by gendered divisions. Research has demonstrated that gender is a significant organising principle within urban food production, ranging from divisions of labour to challenges, opportunities and benefits. Certain features have shown notable resilience across geographical, cultural and social contexts. The disadvantaged position of women in virtually all aspects of urban farming is one such an example. At the same time, gender systems within urban agriculture are rife with contradictions; what is considered genuinely masculine in one setting may well be regarded as a shared responsibility in another. On a very general scale, conditions in West Africa appear to be distinct from conditions in East and Southern Africa, which demonstrate greater similarities. However, local variation is significant and it is likely that elements like culture, social status, economic development and education levels have a profound impact.

INVOLVEMENT

It is readily assumed that women in sub-Saharan Africa tend to dominate urban agriculture in numbers. Indeed, women do constitute a significant majority of urban farmers in East and Southern Africa, but this relationship is not as given in West Africa where the degree of involvement is more unbalanced towards men (Drechsel et al., 2013; Hovorka & Smith, 2006; Ngome & Foeken, 2012). Higher proportions of women are normally attributed to two factors: their overall lower levels of education, making it difficult to find formal employment, and the fact that farming merges well with traditional female chores, such as domestic duties and child rearing. In addition, women are often responsible for household sustenance; thus, engaging in farming can be seen as a way to fulfil social expectations on women's roles (Hovorka, 2006a; Hovorka, 2006b; Ngome & Foeken, 2012).

According to Simiyu & Foeken (2013), open-space and off-plot farming is more common in West Africa, where production types tend to be dominated by men. In Ghana, men's greater involvement is associated with the ideology of the male breadwinner, which translates into the understanding that men are "expected to bring food home" (Adeoti et al., 2012, p.243). The relatively higher commercial orientation of UPA in West Africa is another commonly suggested factor behind men's predominance (Maconachie et al., 2012).

DIVISION OF LABOUR

It is with regards to gendered divisions of labour within UPA that local variation becomes most pronounced. There exists a division of labour based on sexual difference within all researched communities, but their character and internal logic vary considerably.

Women are typically involved in planting, weeding and hoeing (Hovorka, 2006a), while men dominate in preparing the land for sowing (ibid; Adeoti et al., 2012). There is a general preconception that men are more suitable for tasks that involve arduous physical labour (Adeoti et al., 2012; Danso et al., 2004; Maconchie et al., 2012). However, Simiyu & Foeken (2013) note that in Eldoret, Kenya, 25% of women farmers assumed sole responsibility for land preparation, which is considered one of the most physically demanding tasks. This is a far higher proportion than in rural areas and could be related to the fact that urban plots are smaller and more continuously farmed, thus making labour less strenuous. This can be seen as an example of how urban conditions may contribute to changing traditional rural patterns of gendered divisions of labour within agriculture.

Keeping livestock is mainly considered a male domain, while horticulture is a typical task for women (Ngome & Foeken, 2012). Studies in several towns and cities in sub-Saharan Africa reveal that women dominate in selling produce (Adeoti et al., 2012; Kadenyaka, 2012; Maconchie et al., 2012). This is partly related to the fact that it is a flexible occupation that is easy to combine with other duties, but also due to the assumption that women have better bargaining skills (Danso et al., 2004; Simiyu & Foeken, 2013). This tendency is not recognised in Buea, Cameroon, where men in conjugal households appeared to increase their involvement in connection with harvesting and selling. Ngome & Foeken (2012) sees this as an indication of men's attempts to capture the benefits of their spouses' work.

ACCESS TO RESOURCES

Access to productive resources is usually where women face most challenges. Research has shown that women are discriminated in most aspects relating to agricultural resources, such as land, credit, inputs (seeds, fertilisers, pesticides, fodder, water) and external labour (Hovorka, 2006b). As a result of difficulties in accessing inputs, women tend to grow crops of lower value and lower start-up costs (Hovorka, 2006b). In Accra, more men than women were able to secure reliable water access and, therefore, produced a higher proportion of water-demanding crops that generated higher profits (Danso et al., 2004). In Kampala, it was revealed that women specialised in products that demanded less time, work and investment in relation to those of men. This decision was connected to women's limited access to funds, but also to their relative larger time-burdens associated with reproductive duties (Nabulo et al., 2004).

Available vacant land is typically allocated to men, leaving women with plots of lower quality that are sometimes located far away from the home. Nevertheless, a majority of women still farm on plots near their place of residence, but increased proximity typically means a reduction in plot area (Hovorka et al., 2009; Hovorka, 2006a). Van Averbeke (2007) confirms this relationship in a study from Pretoria, where women resorted to home-based horticulture in response to gendered divisions in access to public land and water. In Greater Gaborone, the male dominated Land Board has been known to deliberately delay women's applications for land (Hovorka, 2006a). Women in Accra found it difficult to access private land since their yields were expected to be lower than men's. Part of the produce was often used to pay land rent and land owners; therefore, tenure agreements with men were perceived to be less risky (Danso et al., 2004).

On the other hand, the same study revealed very few cases of gender discrimination in accessing government owned land (Danso et al., 2004). The same can be said about Buea, Cameroon, where the abundance of open urban land, in association with 90% government ownership, had resulted in almost equal access (Ngome & Foeken, 2012). Generally, it can be assumed that the greater the scarcity of land, the greater the extent of discrimination with regards to land access. However, it should not be forgotten that constraints to land access have sometimes worked to the advantage of women in the sense that they have been forced to deal with their disadvantage creatively. Hovorka (2006a), for example, demonstrates how women in Greater Gaborone resorted to the less land intensive practice of poultry production as a response to the difficulties in accessing land. The enterprises turned out to be more profitable than crop production, resulting in an elevation in societal status and standard of living. Nonetheless, it can be expected that this constitutes an exception and that gender-based land discrimination at large leads to significant productivity losses among women.

OPPORTUNITIES

There is little doubt that gender relations affect the character of urban food production, but there is also a belief that UPA may have an impact on societal gender divisions (Simiyu & Foeken, 2013). As such, UPA may provide opportunities for women's empowerment, but according to Hovorka, this usually takes place under "formidable constraints" (2006a, p.216). In many sub-Saharan African societies, women have subordinate roles in household decision-making, including agricultural activities. For example, male consent is often required to start operations. Restrictions on mobility can also be a problem; this can reduce the search space for adequate plots or the ability to travel in order to buy inputs or sell produce (ibid; Hovorka, 2006b).

It is particularly cash contributions that may strengthen a woman's position within the household and the wider community. More specifically, this relates to creating an improved bargaining position in intra-household conflicts as household dependency on female income increases (Hovorka et al., 2009). Maxwell (1995) noted that women in Kampala covertly challenged their husbands' authority by underreporting the extent of income generated by urban farming. He also found that in conjugal households, the financial contribution of UPA was used to supplement private and not household incomes (Maxwell, 1995). Income concealment among women farmers was also noted in Eldoret, Kenya (Simiyu & Foeken, 2013) and Pretoria, South Africa (van Averbeke, 2007).

Organisational membership is another path towards increased empowerment. In Sierra Leone, obstacles to urban farming faced by women have resulted in an upsurge of cooperative organisation aimed at voicing their concerns and strengthening bargaining power. This type of collective action has led to increased female autonomy in production decision-making as well as in control over income (Maconchie et al., 2012). Access to social networks, whether formal or informal, may constitute a positive externality of urban farming, with subsequent impacts on women's empowerment (Hovorka et al., 2009).

In a study from Cape Town, Slater (2001) demonstrates how urban farming carried out for recreational purposes, rather than as an income generating activity, led to increased psychological empowerment. This was particularly the case in milieus where extreme expressions of male domination, such as continuous threats and exercise of physical abuse, had a detrimental effect on women's well-being. Under those circumstances, urban gardening provided a haven where women could achieve peace and quiet. Gardening made them feel productive and fostered feelings of self-worth, despite oppressive environments. It also provided opportunities for small talk with female neighbours, which eventually created feelings of solidarity, comfort and mutual support.

TRENDS

It is difficult to make any kind of prediction regarding the gendered dimensions of UPA due to the lack of current and past data. However, there has been an upsurge in general interest in UPA over the past decade; this has also involved a gender dimension and it is likely that this interest will continue to grow. Gender and UPA has received increased attention by the aid community, which is now progressively targeting women in urban agriculture as a way to stimulate food security and address gender imbalances in households. In association with development interventions however, it is important to acknowledge the need to make a profound assessment of the gender situation. If not, there is a risk that development efforts end up supporting technologies and methods predominantly targeting male aspects of urban agriculture, such as commercially oriented production (Hovorka, 2006a; Ngome & Foeken, 2012). Likewise, interventions that aim at scaling up women's operations must simultaneously address imbalances in the distribution of household workloads so that women's labour burdens are not increased (Simiyu & Foeken, 2013).

KNOWLEDGE GAPS

Gender and UPA still constitutes a relatively unexplored research terrain where many questions remain unanswered. In general, regional differences in gender involvement clearly requires more attention. There are few concise cross-country studies as most available data originates from single-city case studies. There is a particular need for empirically grounded, comparative studies on how men and women's involvement changes over time and in relation to macro scale transformations. For example, Ngome & Foeken (2012) explain how the decrease in purchasing power has pushed women to engage in UPA as an activity to supplement household incomes. Simultaneously, economic decline with associated cuts in formal employment causes men to fall back on traditional female sectors (Simiye & Foeken, 2013). Thus, economic transformation has an effect not only on the practice of urban agriculture at large, but also on its associated gender dimensions.

There is a geographical imbalance in the available research on gender and urban agriculture. A majority of academic papers are devoted to the study of conditions in West Africa, particularly Ghana. Thematically, there is a relative lop-sidedness towards horticulture and crop cultivation and little attention has been directed towards the gendered realities of urban livestock ownership (particularly large livestock) and aquaculture. In addition, there are few studies specifically looking into the distinctions of urban and peri-urban farming from a gender perspective. Information about the relationship between gender and environmental impacts of UPA is also severely lacking. Since there are dissimilarities between men's and women's degree and type of involvement, they are likely to affect and be affected in different ways by negative externalities of UPA. For example, since women's land access is constrained in relation to men's, it can be expected that they, to a greater extent, farm in hazardous locations with associated health risks.

Several studies treat the locals' own perceptions of gendered divisions as explanatory factors. Rather than focusing only on local interpretations of the gender system in UPA, it is important to recognise how these were conceived. In other words, why is a type of vegetable or a specific task regarded as typically male/female (or gender-free) in one setting but not in another? In order to address gender inequalities in urban food production, it is vital to understand how they emerged, how they function and how they are being upheld. This requires in-depth, qualitative studies of a kind rarely seen in this field.

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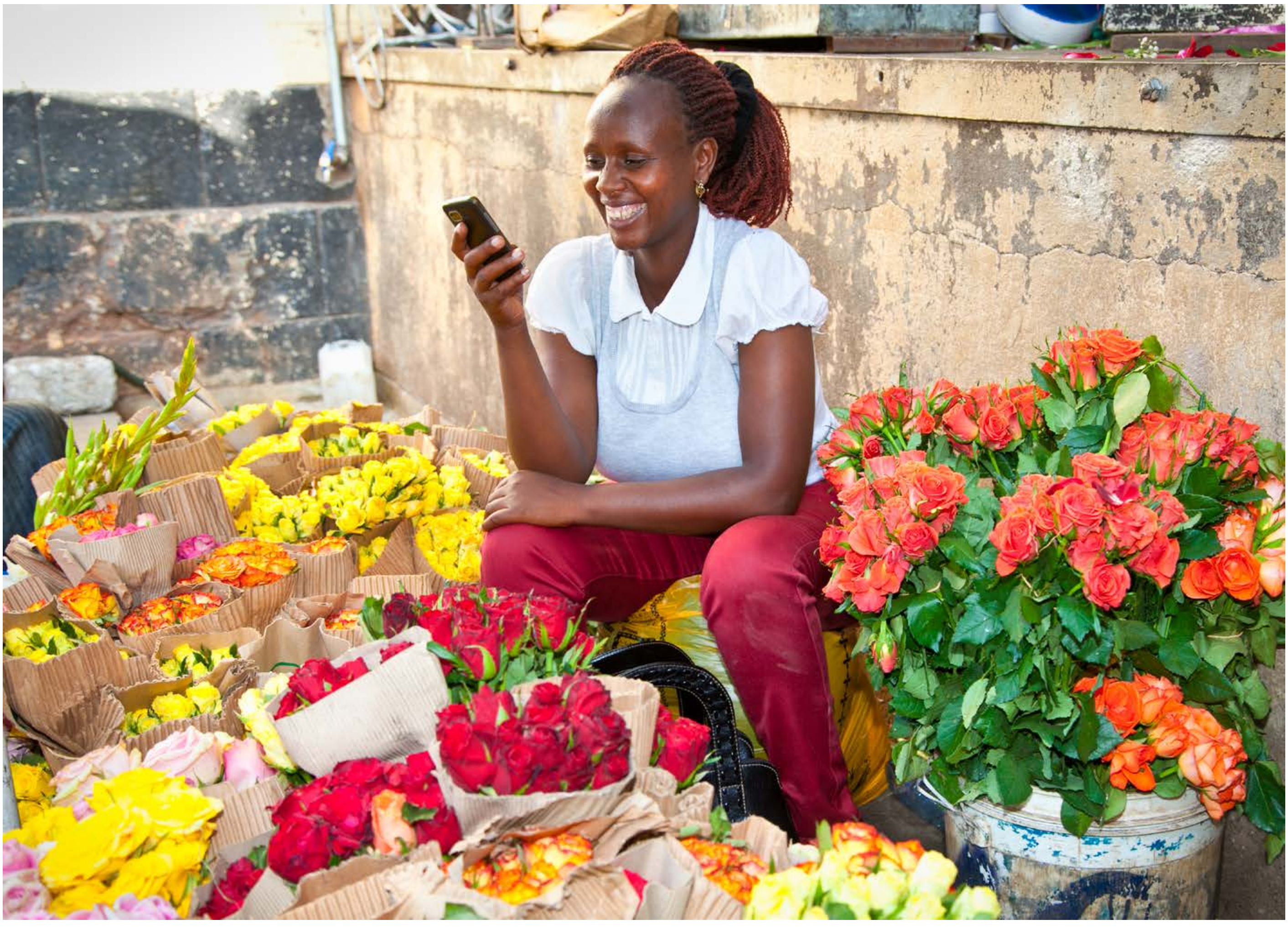

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Potential of productive waste management systems in low-income countries

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In low- and middle-income countries, often neither waste nor wastewater are fully collected and treated, resulting in major impacts on the environment and health. Urban and peri-urban agriculture provides both food and income to many urban poor, but productivity of land is decreasing. Tackling these problems simultaneously enables solutions for both issues by introducing systems where organic waste is turned into high-value products and safe fertilisers.

From a global perspective, between 15 and 20% of consumed food is produced by urban agriculture (Corbould, 2013). Urban production varies between countries, with a greater proportion taking place in low-income countries. Vietnam has the highest participation in local production of urban food; in Hanoi, 80% of fresh vegtables and 40% of eggs are produced within city borders (Corbould, 2013).

Some of the major factors that affect urban agriculture production are legislative, landowner issues and city policies. In areas with a low acceptance for urban agriculture, production is mainly in low-price crops to avoid goods being stolen and/or destroyed (Thomas et al., 2012). Additionally, when land ownership is not clear, cultivation is mainly focused on the next harvest; issues like improving land quality and maintaining high fertility of soil are given low priority. For larger production, these are issues that have to be dealt with. Urban and peri-urban farmers need assurance that they can keep their harvests.

Legislative issues are even larger when it comes to animal farming in urban contexts. In many countries animals are not allowed within city limits. At the same time, animal produce is one of the main sources of protein among the urban poor. For example, in Kampala, Uganda, a high animal density is found in poor, peri-urban areas, especially where migration from the countryside is the largest (Komaketch et al., 2013). Typically, the unemployment rate is often very high and average income is very low. Animal farming is often a good source of income in poor areas (Hoornweg & Munro-Faure, 2008). Landless animal production results in a lack of proper manure management systems; over 60% of produced manure in Kampala is discarded or dumped (Komakech et al., 2013). Unattended manure is washed away during heavy thunderstorms and ends up in lower valleys; this results in pollutants inside the houses of low-lying dwellers or in rivers and wetlands causing health hazards and environmental degradation, including eutrophication.

Other produced urban waste is mostly dumped, either in controlled city landfills or in un-controlled dumpsites (Komakech et al., 2014). Waste management is mainly performed by scavengers/waste pickers who collect all material of value that can be recycled. Organic material does not have any value, thus, the material remaining after sorting and recycling is mainly organic matter. This fraction of waste in landfills is causing a large negative impact on the environment due to the production of greenhouse gases such as methane, a greenhouse gas that is 25 times stronger when compared to carbon dioxide (IPCC, 2007). The possibility of transforming organic waste to valuable fertiliser is most often not recognised by local communities and, therefore, not utilised. Many projects have been developed and tested for organic waste management, mainly by composting and soil production (Komakech et al., 2014). However, very few of these systems have been successful enough for self-seeding after the finalised project. The main part of recycled organic waste is material directly reused as animal feed, especially market waste and crop residues. The amount of waste produced from the food distribution chain is large in low- and middle-income countries, mainly due to the lack of cold storage and underdeveloped infrastructure. This leads to a loss of between 30 and 50% of produce before it is sold at market (Gustavsson et al., 2011). By having local production of fresh goods, the risk for losses decreases as transport time decreases. The large pre-market loss is opposite to non-consumed food in OECD countries, where most of the losses in the food chain occurs post-sales. In this case, it is in the homes of consumers that up to 25% of food purchased is not consumed (Gustavsson et al., 2011).

POLLUTION BY UNUSED WASTE

Connecting produced waste with the need for fertiliser solves two problems: decreasing soil fertility and pollution of organic waste into the environment. Local small-scale composting has proven to be efficient as a waste management strategy with small emissions of greenhouse gasses (Ermolaev et al., 2014). The production and reuse of compost is well in line with the FAO model for sustainable intensification of crop production, "Save and Grow", where compost is strongly promoted due to the improvement of soil quality (Hoornweg & Munro-Faure, 2008).

Compost cannot fully replace other fertilisers as some nutrients, and especially plant available nitrogen, are low, but the effect on poor and highly weathered soils in many African countries is good. However, treatment methods and materials other than organic waste can increase fertiliser value, e.g. toilet fractions. As mentioned above, even if compost is recognised as a high quality soil amender, it is often not enough of a driving force for people to produce their own compost. Stronger driving forces are required for waste and manure fractions to be collected and managed in a proper way. Looking at the organic

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waste value chain, market waste does have a commercial value as animal feed in areas with many urban animals; however, in areas without animals, this resource is not utilised to the same extent as the product value often is less than the cost of the transport. Biogas production by anaerobic digestion provides a value chain with higher market value. In warm climates, simple systems often suffice for production of gas to single households or to numerous households. It can be fed with organic waste as well as animal and human manure. The systems are wet processes, and the liquid needs to be removed prior to reuse, as the market for a slurry-based fertiliser is minimal due to high transportation costs. One step further up the value chain is production of protein products intended for animal feed. This can be achieved either by vermicomposting or by fly larvae composting. In both processes the materials are degraded by arthropods that are harvested and used as protein rich animal feed. Both processes have high conversion efficiency. The feed material produced amounts to up to 10% by weight of the incoming waste (Lalander et al., 2013). According to the FAO, insect based food and feed production has to increase during in the coming years in order to feed a growing global population (van Huis et al., 2013). A smallholder manure management system based on vermicomposting for fertiliser and worm production was developed by Lalander et al. (2014). The system, a one square metre vertical treatment unit, could process about ten kilos of manure per day; it produced over 20 kg of worms per month to a value of over €400 in Kampala during the second half of 2013.

When closing the loop of nutrients, either via the field or directly via fly larvae or worms for animal feed production, there is an increased risk of disease transmission. This has to be addressed in the treatment and handling system as it otherwise risks compromising confidence in the biological treatment and reuse system.

The potential of recycling nutrients from food, animal and human waste as a plant nutrient resource is large in relation to the use of mineral fertilizers. In Uganda, the potential for nutrient reuse from waste and manure corresponds to over ten times the amount of imported fertilisers (Clemens et al., 2012); in the whole sub-Saharan region, the amount of nitrogen and phosphorus in urine and faeces alone is larger than the use of mineral fertilizers (Rockström et al., 2008). Furthermore, nutrients in food, animal, and human waste are local resources available for all, even the poorest. It does not need to be imported, does not strain currency balances and is not controlled by world market prices, as mineral fertilisers are. However, for people to appreciate these local nutrient resources, their value chain may require production of a high value product such as feed protein production from waste and manure (Lalander et al., 2013) or biogas production in low-tech reactor systems (Yen-Phi et al., 2009).

An important risk with plant nutrient recycling systems is recycling of disease causing microorganisms. Many of the traditional manure and organic waste systems do not take this aspect into account, even though it is needed for a successful management system. For disease risk management, simple measurement methods to monitor the quality of produce even at local levels must be developed. Furthermore, it is important that people using the systems understand the risks associated with the spread of diseases from different materials (Mariwah & Drangert, 2011).

TRENDS

Most likely, one of the post-2015 Sustainable Development Goals will be eradication of hunger, as it was recommended by the High Level Panel for example (2013). As the demand for local food production increases, there will be an increased demand for fertiliser. If that can be solved locally, poor urban farmers will have the opportunity to prosper from increased growth.

Alternative value chains, including production of animal feed by earthworms and fly larva, results in the production of organic fertiliser at the same time as high value animal feed. By doing this, an incentive for waste management is presented that can sustainably finance waste management through sale of products, as opposed to waste fees that often the poor cannot afford.

OPPORTUNITIES

The major opportunity with introducing productive waste management systems is closing nutrient loops. The introduction of a waste management system decreases environmental and health risks, while providing a system for local, high value products like feed protein, biogas and fertiliser.

Managing waste can go beyond chemical pollution by plant nutrients and its following eutrophication; there are also ways of containing disease-causing microorganisms such as collection and treatment to remove most of these pathogens.

CHALLENGES/OBSTACLES

Acceptability of different recycling systems varies between regions. However, today uncontrolled recycling systems are very common, e.g., uncontrolled use of wastewater for irrigation purposes. But, when starting to introduce planned recycling systems many people are initially sceptic. Thus, attitudes towards the products, both fertiliser and protein, need to be changed in order to increase the role of recycling waste management systems in societies.

KNOWLEDGE GAPS

The major knowledge gap in productive organic waste management is the development of low cost, robust and simple treatment systems that produce safe end products and simple, cheap monitoring systems to confirm that they are safe.

Additionally, when introducing productive waste management, e.g., protein production from organic waste, there will be a shift in both animal and environmental health. The impact from changes to increased local production and removal of pathogens is hard to estimate today. Epidemiological studies of the effects on animal and human health would add to a holistic understanding of the impact of changes in management systems.

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Microbial food safety and zoonoses in urban and peri-urban agriculture

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Zoonoses are infectious diseases transmitted between animals and humans, for instance by food or close contact. They are estimated to account for 70% of all emerging infectious diseases affecting humans and are of great importance for public health, food safety, food security and the economy. Urban and peri-urban agriculture (UPA) leads to spatial clustering associated with different scales of production and different levels of biosecurity. The risk perception related to food safety is influenced by socioeconomic determinants in the household (Dosman et al., 2001); thus, economic development in low-income countries may generate new demands on food safety.

There are many factors influencing the circulation of zoonotic pathogens from farm to fork and the hazards and risks faced in UPA may differ from those in rural production systems. Notably, most food from UPA is marketed through informal markets where actors are not licensed and do not pay tax, where traditional processing dominates and where effective health and safety regulation are non-existent (Bryld, 2003). At the same time these markets provide employment and access to food for millions.

MICROBIAL FOOD SAFETY

Food safety is a concept relating to handling, preparation, and storage of food in ways that prevent foodborne illnesses from production to consumption known as the "farm-to-fork" or "stable-to-table" concepts. These include issues on specific chemical, physical and microbial hazards (e.g., fungal toxins, drug residues, parasites, viruses and bacteria), but also the environments where food chains are operating and that are facilitated by policy. Food is not only nutritious to humans, but also an ideal breeding ground for bacteria. Therefore, this chapter focuses on food as a vehicle for the transmission or growth medium of microbial pathogens causing human illness. Examples of such pathogens are Brucella in unpasteurized milk (Makita et al., 2012), Salmonella spp. shed by pigs (Ikwap et al., 2014), and faecal coliforms on vegetables (Amoah et al., 2006).

There is a shift in consumer behavior in urban areas where more consumers have access to supermarkets. This is however not equivalent to safer food (Grace et al., 2012a) as additional steps in the food chain exist, compared to markets where producers sell their products directly to consumers. Additional steps in the food chain may even favor the growth of pathogens. There is also a risk that 'supermarketisation' makes local producers lose market access. Fresh produce is particularly associated with proximity to markets, which often is the case in urban areas. In urban centers of developing countries, between seventy and ninety-five percent of all vegetables may originate from this production system (Amoah et al., 2007; Ndiaye et al., 2011). With increasing urbanization consumers' demand for fresh vegetables is growing, but these products are perishable and easily spoiled if transport distances get longer and cold chains less reliable.

For vegetables, there are several sources of microbial contamination in the production chain such as presence of pathogens in the soil, application of contaminated manure, irrigation with un-treated water and wastewater, and cleaning of the product in polluted water before selling. Even so, the majority of microbial contamination of vegetables produced in urban areas occurs during primary production, implying that post-harvest processing and handling does not necessarily increase levels of contamination. Levels of fecal coliforms in water used for irrigation often exceed the WHO wastewater irrigation guidelines (Amoah et al., 2006; WHO, 2006) and presence of zoonotic pathogens, such as Salmonella spp. (Ndiaye et al., 2011). However, banning use of wastewater for irrigation may drive small-scale farmers into poverty as there is little access to other water sources. The methods to decrease levels of contamination at primary production can be simple, for example, by prolonging the interval from the last irrigation to harvest (Stine et al., 2005).

Increased urbanization and higher income in cities have also lead to a greater demand for animal source products such as milk, meat and fish. In addition to bacterial diseases infecting live animals such as brucellosis, harvest and post-harvest handling is vital for managing microbial contamination. For milk, these critical points include milking hygiene, bulking and adulteration of milk as well as proper heating or cooling of milk. For meat, these points are similar and are mostly related to hygienic slaughter, transport and handling of raw meat. In addition, stress-free transport of animals destined for slaughter has a high impact on the shelf life of meat.

Large scale commercial businesses like processing plants or slaughter houses offer certain food safety benefits, for instance, enhanced disease surveillance and centralized food inspection. On the other hand, they add additional steps between primary production and consumption that may lead to cross-contamination and increased bacterial growth.

The levels and sources of contamination have to be assessed throughout the production system to detect critical control points from production to consumption, specific for urban food production. Pathogenic microorganisms have been detected all along meat and dairy value chains (Ahmed & Shimamoto, 2014), but this does not mean that they end in consumers' stomachs if, for instance, the food is well cooked. Such investigations are called systematic risk assessments and they are important tools in managing food safety. It has, for example, been shown that eating vegetables poses a greater risk for public health compared to handling cattle or drinking milk, even though cattle are the main reservoir for infection (Grace et al., 2012a). This illustrates the risk perception for zoonotic food borne infections can be misleading. Methods to improve food safety can be cheap and simple: traditional food processing methods, for example traditional milk fermentation, can significantly reduce the burden of some pathogens in milk (Makita et al., 2011); the use of chlorinated water (WHO/FAO, 2008); or the increase of knowledge, attitudes and practices (Grace et al., 2012a). It has also been shown that targeting women might be more efficient to improve food safety practices and thereby reduce illness among consumers (Grace et al., 2012a). Decriminalizing informal markets may be another strategy to improve food safety, since there will be little reason for people to invest in good practices voluntarily if criminalized.

NON-FOOD BORNE ZOONOSES

The main peculiarity, and at the same time risk factor, related to non-food-borne zoonoses in UPA is that live animals are kept or marketed in close proximity to large and dense human populations. One of the most discussed infections in this context is the highly pathogenic avian influenza (H5N1) in poultry, primarily in Asia and Africa. Although infection in humans with H5N1 is rare, there has been, and remains, a fear for acquisition of virus mutations in poultry that may lead to more efficient spread among humans and other mammals. This fear made authorities in several Asian countries ban poultry keeping in towns. Live bird markets have also been identified as a major risk factor for humans acquiring the disease (Anderson et al., 2010; Van Kerkhove et al., 2011).

Yet, not all zoonoses are spread by contact or aerosols like influenza virus as some, like Japanese encephalitis virus in Asia, are spread by biting mosquitos. Birds and pigs are important reservoirs for the causative virus and the disease has, therefore, been regarded as a "rural disease". However, recent studies in Vietnam have shown that pig-keeping in urban or peri-urban areas attracts mosquito species competent to transmit the virus and that these mosquitos as well as the pigs are infected by the virus (Lindahl et al., 2012; Lindahl et al., 2013). Thus, pigs in UPA may, in some regions of the world, pose a serious threat to public health.

Manure from animals infected with parasites or bacteria may also serve as a vehicle for the spread of zoonoses (Bicudo & Goyal, 2003) via food or water, especially in UPA.

Another zoonosis that is prevalent in urban settings is rabies, even though perhaps not directly related to UPA. In low-income countries, the majority of human cases of rabies are connected to canine rabies and the highest densities of dogs are found in cities (Davlin & Vonville, 2012). This implies that unvaccinated stray dogs in urban areas pose a significant risk to humans. There are several other examples on how zoonotic diseases are frequently transmitted from animals to humans in urban areas and these diseases sometimes pose a larger threat to public health than in rural areas.

TRENDS

Increasing urban populations of low-income countries with higher household incomes tend to change their food habits towards increased consumption animal products, fresh vegetables and fast food. These growing urban populations lead to increased urban food production, which has effects on both food safety and transmission of zoonotic pathogens as outlined above. One reason behind this is the lack of cooling facilities, which does not allow transport and storage, consequently making UPA economically competitive. Another is the influx of rural dwellers to cities that maintain parts of their agriculture practices for livelihood and food security reasons. The Asian experience has shown that by increasing wealth and improving infrastructure, the animal branch of UPA has especially diminished or disappeared. Notably, in many countries, governments have banned keeping livestock in cities, but these regulations are not always fully implemented. The importance of urban animal production is expected to increase with larger commercial operations in densely populated areas, which leads to new challenges in managing food safety and zoonoses.

CHALLENGES

There are several challenges that represent serious constraints to the further development of UPA. Contagious diseases, including zoonoses, have negative impacts on animal production and constitute public health risks. The spread of such diseases, and also emergence of new diseases, is facilitated in areas where there are markets selling live animals and where density of people and livestock is high. When UPA production increases, new challenges to control contagious diseases occur. Animals in UPA also produce manure that, to some extent, are used for local crops, while some are bagged, sold or left as pollutants. All of these uses pose risks for disease transmission from manure to animals as well as to humans. Manure can also pollute wastewater used for irrigation of vegetables, thereby constituting public health risks through consumption of vegetables. A systemic approach, taking into account public health, sociology, economics and veterinary medicine, is needed to solve challenges related to UPA. Large-scale commercial businesses offer certain food safety benefits, but may add additional steps between primary production and consumption. This may lead to cross-contamination and increased bacterial growth.

OPPORTUNITIES

High value commodities like fresh fruits, legumes, eggs, dairy and meat products produced close to a large market, like a city or town, are a great opportunity for producers to make an income, lifting them out of poverty. Also, these commodities have a very high nutritional value of vitamins, essential amino acids, trace elements and protein that are particularly important for young children and women of reproductive age. Thus making a significant contribution to improved food security. UPA is also a way to mobilize resources that cannot be used for food production by other means like marginalized urban/peri-urban land, waste and wastewater. Finally, small-scale UPA is very feasible as a part-time activity for women as it can be combined with household work. Much attention has been paid to the role of informal markets in maintaining and transmitting diseases, but little to their role in supporting livelihoods and nutrition (Makita et al., 2011).

KNOWLEDGE GAPS

For UPA in low-income countries, there is an obvious and delicate tradeoff between microbial food safety and protecting the public from zoonoses one hand and food security and poverty reduction on the other hand. Thus, it is critical that decisions for regulations and/or incentives for UPA by governments and other stakeholders are based on best available knowledge.

A starting point is to identify which production systems or where (incl. quantify) or along which part of the production chain are public health risks the highest. There are a lack of such systematic risk assessments that may form a basis for finding out measures that mitigate these risks in low-income countries. Such measures might be technical as well as policy/regulatory oriented. Studies are scarce where the risk mitigating strategies are balanced in a cost-benefit framework against the positive aspects of UPA, yet are clearly needed. Messages to be communicated to UPA producers for safer production with respect to microbial food safety and zoonoses must be packaged in a culturally sensitive way to be meaningful. Knowledge about how to improve communication with UPA producers as an area in and of itself contains large gaps.

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Potential of urban horticulture to secure food provisions in urban and peri-urban environments

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The production of vegetables and fruits within urban and peri-urban boundaries provides food for millions of Africans in urban areas as well as livelihoods for thousands of urban growers. Thus, the socio-economic impact of urban horticulture is substantial. There is also a positive effect on the environment through conservation of natural resources in city areas. However, there exists a need for technical development and official recognition of this type of production to enhance sustainability.

Poverty is one decisive factor adventuring food security and an important cause for mal- and under nutrition as well as undernourishment. Migration from rural to urban areas and expansion of urban areas attributes to urban poverty but also to increased distance between the traditional sites for food production, i.e. rural areas, and consumption. Also the consequence of environmental damage, in terms of global climate change, results in decreasing space suitable for crop production, which feeds growing urban and peri-urban populations. The conflict of land use, particularly food crops vs. energy crops, is another challenge facing food security. These scenarios may vary in different parts of the world. Growing urban reliance on rural sources of food as well as agricultural production occurring in urban areas are important components of livelihoods that operate along a rural-urban continuum (Foeken & Uwuour, 2008; Tacoli, 2006). The ruralization of urban livelihoods, however, occurs within an institutional and physical context that is very different from the countryside, with urban agriculture being, perhaps, the most tangible expression of this ruralization.

Fruits and vegetables are the basis of a healthy diet; horticultural produce is rich in fibers, minerals and bioactive compounds. With staple foods like cassava, maize and rice, diets must be balanced by consumption of vegetables and fruits in order to avoid diseases among the population due to deficiencies. Deficiencies of micronutrients like Vitamin A, iron, zinc and iodine are extremely common within urban sub-Saharan populations (Tenkouano, 2011). More than 17 million people suffer from Vitamin A deficiency in West and Central Africa (Ezzati et al., 2002).

Horticulture is ideal for conditions prevailing in urban areas as it is characterized by high turn-over, high resource efficiency, high yield and good quality as well as flexible land use and production of several crops during one season. Horticultural production provides more efficient land use by allowing substantial cropping in limited areas through efficient low-tech production systems like vertical cropping. For example, production in bag gardens (cultivation in hanging bags filled with soil and manure) has become more utilized throughout Africa and helps to increase food security and eco-social capital for households. Examples from Kibera, an informal urban slum settlement in Kenya, show substantial impact on dietary diversity in households undertaking bag gardening (Gallaher et al., 2013).

Urban horticulture not only provides plant-based food of high nutritional and health value, but also offers secure livelihoods. Over 70% of urban growers in the city of Tamale, Ghana, state their main occupation as vegetable growing, primarily for market and less for their own consumption (Abubakari & Mahunu, 2007). However, to a large extent, urban and peri-urban horticultural production is undertaken without any official recognition (FAO, 2012). Without support and regulations from governments, there is a risk that optimizing economical returns leads to an unsustainable situation by unregulated use of pesticides and polluted wastewater. Well-managed vegetation cover from urban horticulture has a positive impact on urban environments. Bernholt et al. (2009) studied the effect of species richness and diversity in home and commercial gardens in Nigeria. The highest diversity was found in large, well maintained peri-urban gardens with production of mainly vegetables and fruits for market.

TRENDS

Urban horticulture is an outermost important factor in providing city dwellers with nutritious food and its importance will develop further. It will also be an increasing driver of growth in the horticultural business as such. However, the full potential of urban horticulture as a food and livelihood provider will only be achieved when it is integrated in urban land use planning and policy making addressing both potential benefits` and risks. Well-managed urban horticulture will be an important tool to reduce poverty, improve environmental management and further economic development in many cities of developing countries.

OPPORTUNITIES

Food security is measured by different indicators based on static and dynamic determinants describing availability, physical and economic access, utilization, vulnerability, and outcomes, in terms of access and utilization (FAO et al., 2013). The presence of infrastructure results in production of fruit and vegetables in urban areas that increases access to fresh produce of high nutritional value; this impacts the quality of diets and, consequently, supports the struggle against undernourishment. In developing countries, urban horticulture offers another dimension to secure food as it contributes to livelihoods (Parrot et al., 2008). Furthermore, closure of resource flows within urban areas may display an attractive approach to sustainable city environments. Also, horticultural cropping systems in urban areas may be linked to production of animal proteins in aquaculture through the use of aquaponics, where fish production is linked to horticultural crop production. Urban horticulture also contributes to ecosystem services other than food provisioning; it affects ecological processes and dimensions in cities, including climatic factors such as, air quality, biodiversity and water management. Depending on the choice of cropping system and site, it also affects energy provisions. However, the multi-complex nature of synergies achieved through urban horticulture does not always go hand in hand with high food quality and efficient use of resources. It requires an integrated view of the phenomenon by all parties, such as politicians, legislators, city planners, enterprises, landowners, producers and inhabitants. It requires action not only on a local, but also on a national and international level. When these concepts can be transformed into operational standards and actions, urban horticulture can contribute to food security, food safety and livelihoods, while offering considerable potential for innovation.

CHALLENGES AND OBSTACLES

Food production through urban horticulture illustrates obstacles at different societal levels that are strongly interrelated. It displays a classic example of the use of common pool resources (Ostrom, 1990) that, in many cases, are coupled with an uncertain situation regarding land use. The lack of institutional structure and permits regulating land use results in less focus on long-term strategies to govern and maintain public or common sites used for growing food crops in urban areas; in turn, this has substantial consequences for sustainability, both for urban environments and for cropping systems. However, sustainability is not only at stake due to land use for urban horticulture, it is also affected by the general institutional structure for sustainable development within the country, as common pool resources such as water, soil or air may be signed by environmental pollution. This puts food safety and, thereby, public health and food security at risk.

Food hazards may be of physical, chemical and microbial nature. Literature focuses mainly on adverse hazards related to chemical and microbial hazards. However, potential physical food hazards in fruit and vegetables produced close to major roads, railways and riverbanks as well as abandoned industrial sites should not be neglected. Chemical food hazards, in regards to water and soil pollution (persistent organic pollutants, industrial chemicals and contaminants, heavy metals, residues of antibiotic and plant protection products), endanger the product quality of harvested produce (Khan et al., 2008; Nabulo et al., 2010). Fungal secondary metabolites (mycotoxins) may also put the product at risk. The absence of legislation regarding chemical plant protection, due to both their overuse to secure crop yields and to ensure outer product quality, leads to environmental and health problems. Apart from the final product, health implications for producers need to be considered. Microbial contamination may occur during the whole production chain and may be a consequence of contaminated common pool resources; for example, manure in the case of non-sanitized organic manure from animal or human sources and/or wild or domestic animals during pre-harvest. The use of water with inferior hygienic properties for product conditioning to increase shelf-life and counteract crop losses imposes a substantial hazard (Amoah et al., 2006; Drechsel et al., 2000).

KNOWLEDGE GAPS

Apart from hazards, the contribution of urban horticulture to food security requires also that the full potential that horticultural systems exhibit is utilized. This can be achieved by reconsidering management strategies, adequate timing and choice of appropriate means to turn the input of resources into a higher output or a higher quality of output produce.

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PHOTO: ERIK BONGCAM

Staple foods in urban and peri-urban agriculture

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Often misconceived as an oxymoronic concept, urban and peri-urban agriculture (UPA) is in reality a fundamental aspect of the urban environment within cities worldwide (Redwood, 2010). Furthermore, staple foods by their very definition are consumed to provide a principal source of nutrition and energy across the globe (FAO, 1995). This article considers how African UPA and staple foods are inherently linked with issues of nutrition, poverty, security and markets within the first urban century.

Staple foods consist of the major carbohydrates consumed in people's diets (Dorward, 2012) and as such are defined as foods that are eaten regularly and in such quantities that they provide a large proportion of one's energy and nutrients (FAO, 1995). In this regard, staple foods can be considered as foundational building blocks for nutrition and health. The principal role played by staple foods globally becomes evident when considering that of the planets 50,000 edible plants, rice, maize and wheat alone provide 60 percent of the world's food energy intake (FAO, 1995).

On the whole Africa as a continent has suitable conditions for the production of food staples, a fact reflected in that millions of African farmers rely upon staple foods for their sustenance and income (Hazel & Poulton, 2007). While traditional conceptions and logic dictate that spatially demanding staple food production takes place almost exclusively within rural areas, recent UPA research from sub-Saharan Africa has produced some rather surprising results to the contrary. Indeed, evidence suggests that staple foods play a major role in UPA production (Turner, 2013).

Significant staple foods within the African context include maize, rice, roots, tubers and plantains (FAO, 2006). These ingredients are widely used in traditional local cuisines either as an accompaniment to protein or as the primary ingredient in and of itself. Staple foods are also used to a large degree as fodder for livestock production on the continent. As a result of the high patterns of consumption noted above, Africa's demand for food staples is increasing and is set to double from 2007 to 2020 (Hazel & Poulton, 2007).

In line with Engel's law of food expenditure, scholars state that across the globe food looms large upon the budgets of low-income urban households (Cohen & Garrett, 2010). More specifically, it is noted that food expenditure can account for up to 80 percent of total household income for low-income households in sub-Saharan Africa (Baiphethi & Jacobs, 2009). Furthermore, in accordance with Bennett's law starchy staple foods account for a greater percentage of calorific intake amongst poor households than those with a higher per capita income, whom unlike their poorer counterparts posses the purchasing power to satisfy desire for dietary diversity (MEA, 2005).

Given the above evidence and in line with what might be considered common conception, staple foods provide the primary source of sustenance for poor urban households. Urban dwellers face relatively high living costs from housing, transportation, health care, education, inflated food prices and cash requirements when compared to their rural equivalents (Cohen & Garrett, 2010). Compounding these high costs of urban living, the international trade of non-perishable staple foods such as maize, rice and wheat brings the tangible effects of global price fluctuations to the table of the already vulnerable urban poor. In recent years corresponding factors such as poor weather/growing conditions, market deregulation, high import prices, stockpiling, and speculation by merchants have resulted in staple food price hikes that constitute a stark departure from decades of declining staple food prices (Bush, 2010).

Paradoxically, global staple food crises often result in further reliance on non-processed staple foods as consumers abstain from comparatively higher priced animal, fruit and vegetable foods in an attempt to compensate for price spikes (Cohen & Garrett, 2010). Between 2002 and 2008, reports identified a 64 percent increase in overall global food prices with accompanying measureable negative effects on nutrition and food security (Cohen and Garrett, 2010). Furthermore, staple food price rises alone have had devastating consequences for poor households categorized as net buyers of food in economies lacking broad based growth (Dorward, 2012). As an example of the extremity of the recent 2008 shock, during the first quarter of the year the price of wheat rose by 130 percent whilst rice doubled in price. These shocks arguably hit hardest in urban areas where the majority of inhabitants rely upon market sources for access to staple foods. This is especially the case in cities where inhabitants have either limited scope for UPA production or are actively deterred from doing so by government policy and laws.

The severity and extent of the recent staple food crisis manifested in an unprecedented number of urban-based riots, protests and marches in more than 25 countries within the global south between 2007 and 2008 (Bush, 2010). Protestors often started with relatively peaceful activities such as pan banging clad in hessian food sacks adorned with the stark message 'we are hungry'. However, in many cases these protests escalated into full-scale riots resulting in innumerable deaths. Government buildings, shops, and cars for looting and arson, whilst further violence erupted in and amongst rioters themselves (Bush, 2010). While the pressing issues of hunger and access to staple foods during a time of simultaneous plenty and starvation were certainly catalysts for the events which took place, it is acknowledged that broader issues of poverty, power and politics underpinned these events at both national and global scales (Bush, 2010).

The above situation has led scholars to lament that there is not a lack of food in cities, but rather that poor urban inhabitants cannot afford to purchase it. Therefore many urban dwellers turn to UPA as a tried and tested livelihood strategy that has been practiced for generations (Prain & Lee-Smith, 2010). To a large extent most of the produce deriving from urban sources is consumed for subsistence purposes, with only a small surplus reaching markets (Baiphethi & Jacobs, 2009). In this way, UPA can be framed as a coping mechanism that provides a source of staple food production for consumption within the built environment under conditions of severe food insecurity (Florence et al., 2001). Indeed it has been suggested that due to the highly volatile nature of cereal prices many African smallholders consider it too risky to rely solely upon markets for access to staple foods. As a result they devote much of their cultivated land to the production of these essential commodities for self-subsistence purposes, rather than attempting to cash in on higher value vegetables and crops (Hazel & Poulton, 2007). For example, in Mozambique in the year 2000 most urban dwellers had UPA plots producing staple crops that were of greater importance than horticultural varieties due to socio-cultural tendencies and worsening economic conditions at the time (Florence et al., 2001).

In terms of the demographic proportion of agricultural practitioners residing within cities in the aftermath of the recent 2008 food crises, recent UPA research from Ghana has produced interesting results. Preliminary non-published findings from ongoing research funded by VR/UFORSK within two intermediate sized cities, Techiman and Tamale, identified that out of a sample of 2033 households some 26 percent were engaged in UPA. In addition a further 23 percent were found to be involved in rural agriculture, and 5 percent practiced both rural and UPA (Jirström, 2012). Such insight attests to the importance of agriculture within cities as well as the desire amongst urban dwellers to secure food production.

Further evidence from additional recent UPA research in Ghana suggests that staple foods such as maize and plantain are much more important to urban agriculturalists than perhaps previously thought. For example, in Techiman where 14.1 percent of land is estimated to be under cultivation, findings identified that of those UPA sites with a discernable dominant yield type, 61 percent were dominated by maize production, whilst a further 18 percent were dominated by plantain (Turner, 2013).

The explanation for the high prevalence of staple crop production within the rapidly urbanizing and sprawling Techiman comes down to a number of reasons. For example, the short growth cycle of maize minimized the risk of crop loss to urban densification and expansion. In addition, farmers noted that hardy staples require minimal inputs and tender. These agronomical aspects were found to compliment socio-cultural and economic influences such as local cuisine preferences, targeted governmental staple crop initiatives, and the potential to consume and/or sell non-perishable staple produce under temporally shifting market and food security conditions (Mackay, 2013; Turner, 2013).

Interestingly, as a result of the numerous motivating factors outlined above staple crop production in Techiman is not solely practiced by poor inhabitants for basic subsistence purposes, nor is it exclusively undertaken by commercially orientated entrepreneurial practitioners (Turner, 2013). This finding reflects the reality of the diverse yet comprehensive demand for food staples amongst urban dwellers in sub-Saharan Africa.

TRENDS

Projections for sub-Saharan Africa in 2022 indicate a 15 percent increase in the absolute number of food insecure people when compared to 2012 baseline levels, equating to a total of 411 million people. However, due to the regions projected population growth of 28 percent over the same period, the share of food insecure people is expected to fall from 42 percent down to 38 percent. Meanwhile, in North Africa food insecurity is expected to remain stable with the means to provide sufficient supplies over the same projection period (USDA, 2012).

While projections for future demands and developments in agricultural production inherently contain an element of uncertainty, what is clear is that UPA has been an integral part of African urban environments for decades, if not centuries. As such there is no evidence to suggest a future decline in demand for its practice.

OPPORTUNITIES

Staple food production through UPA channels is a multifaceted phenomenon that provides opportunities for food security, nutritional sustenance and sources of income. Clearly any opportunity to increase African food staple production is a pro-poor development strategy given the ubiquitous nature of production amongst smallholders across the continent (Hazel & Poulton, 2007). UPA should not be overlooked in this regard.

UPA staple crop production has been linked with improved nutrition in children due to increased access to food throughout the year (Armar-Klemesu, 1999). Furthermore, UPA maize production provides a vital contribution to the energy content of urban diets in Zimbabwe (Florence et al., 2001), while cassava plays a key urban dietary role as a buffer to high maize prices during the lean season in Mali (Mason & Jayne, 2009). Initiatives aimed at boosting UPA production of such staples could provide a key source of nourishment in the struggle against malnutrition.

In addition to the above opportunities, the potential for farmer education and policy implementation to minimize risk, increase yields and provide resources for UPA continues to be neglected in many respects. Such opportunities exist from local, regional and national governmental programs up to the international institutional scale. For example, the promotion of least risk farming strategies such as selecting seed crops over leaves and roots can decrease metal uptake by 10 to 1 (Armar Klemesu, 1999). Further still, the introduction of new cultivars in Nigeria, Ghana, Benin and Malawi have resulted in increased yields and have been instrumental in increasing per capita food consumption levels (Baiphethi & Jacobs, 2009). Meanwhile, targeted subsidies for improved seed varieties and inputs in favorable growing environments has been recognized as a potential opportunity for boosting staple food production to improve food security at a national scale (Baiphethi & Jacobs, 2009). This approach could be scaled down to the urban setting when considering UPA.

CHALLENGES/OBSTACLES

With regard to challenges and obstacles it is imperative to identify the distinct environmental conditions within which UPA takes place. From an agronomical perspective, factors for consideration include temperature, air and soil quality, solar radiation and climatic patterns. In more detail, factors such as decreased solar radiation, the effect of the urban heat island, increased air, soil and water pollution, short cycle

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horticultural soil depletion, theft and pest damage are all challenges which are specific to or are intensified within urban areas (Eriksen-Hamel & Danso, 2010).

Moreover, land constraints associated with rapid urbanization and subsequent urban sprawl in many developing nations act to limit and remove the space required for UPA. Such issues are compounded in many cases by the limited implementation of planning regulations and often a complete lack of recognition of UPA in official land zoning schemas (Turner, 2013).

There are also real challenges faced with regard to the quality of UPA produce, especially concerning contamination from the use of polluted soil, water, and domestic waste (Quon, 1999). Research in Ghana has documented urban agricultural sites within the immediate vicinity of waste dumping grounds, with some production even utilizing the fertile nature of the decomposing waste (Turner, 2013).

Finally, many of the opportunities noted above will require the support, coordination and expertise of intensive farmer extension services (Hazel & Poulton, 2007), especially given the complex and contentious environment within which UPA occurs. If the challenges noted above are not appropriately addressed so that urban inhabitants can secure some degree of access to food production, then future urban-based food riots, security threats, and health epidemics are likely to proliferate in times of hardship.

KNOWLEDGE GAPS

Despite the efforts of the international research community, stakeholders and non-governmental organizations, the evidence base on social, environmental and cultural implications of UPA remains relatively scarce. Furthermore, there is currently an empirical research gap with regard to the investigation of UPA and nutrition (Stewart et al., 2013). This fact is inherently related to staple food production and consumption, as well as wider conceptions of food security and poverty. This point was brought to light by scholars such as Armar-Klemesu (1999) over a decade ago with regard to the nutritional status of children within farming versus non-farming households and has remained unresolved.

Finally, a lack of comparative analysis on the value of UPA has also been outlined amongst academics such as Redwood (2010), whilst other scholars have called for comprehensive studies on the value of UPA in order to help scale up successes (Cohen & Garret, 2010).

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Aquaculture – a fast growing food production sector

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Aquaculture is the fastest growing food production sector worldwide and its importance is expected to increase even more due to declining supplies from capture fisheries coupled with enormous human population increase. Growing demand for farmed fish and on-going urbanization in most African countries is foreseen to drive the development of urban and peri-urban aquaculture as quick alternatives to fish sources, meeting peoples' needs for nutrition, food security, and income generation.

Aquaculture is developing, expanding and intensifying globally; around 50% of fish for human consumption is supplied by aquaculture (Bostock et al., 2010). In Africa, however, aquaculture production still constitutes a minor part of total fish production, despite the fact that the continent has the fastest growing population (2.5 %), which is second to that of Asia. However, the contribution from aquaculture has relatively increased in many African countries as a result of growing urbanization, expanding markets and services, improved skills, opportunities for private sector development, and new technologies. One example is Uganda where the growth rate in aquaculture has increased with almost 3000% since 1994 (World Bank, 2007). Although subsistence or smallholder ponds still dominate in many African countries, there are examples of more intensive commercial fish farming, for instance in Madagascar, Mozambique, Zambia, Zimbabwe, and Ghana (World Bank, 2007). The main fish species farmed are tilapia (*Oreochromis niloticus*) and the African catfish (*Clarias gariepinus*).

In Africa, aquaculture is to a large extent located in rural areas, with fewer farmers practicing urban/peri-urban aquaculture. In Nigeria, a rapidly growing population and high demand for fish has resulted in the development of commercial aquaculture production in peri-urban areas (Miller & Atanda, 2011). Production mainly consists of African catfish that are intensively raised in small concrete tanks and are often constructed inside home compounds, an approach that reduces the risk of poaching, theft and other challenges. Catfish is a preferred farmed fish due to consumer preferences and its resistance to stressful conditions, such as high stocking densities and live transportation. Investments in good management practices, development of intensively managed hatcheries, and use of high quality feed have been made possible because of strong market forces, i.e. low supply and high demand of fresh fish. Apart from home-based tank fish farming, medium-scale investors have invested in cooperatively managed "fish farming villages" with several hundred fish tanks located near large markets in peri-urban areas.

Several aquaculture production systems in Africa typically operate at a low-input/low-output scale. On the other hand, given the eating habits of urban populations, many urban/peri-urban areas in Africa are major sources of organic waste. This organic waste has the potential to be used as aquaculture feed. When coupled with ready market access, subsistence production may transform to a commercial scale. This has already been witnessed in Cameroon, where fishponds in urban areas were 72% more productive per unit area than those in rural areas. This translated to an increase in fish prices of 48% in urban areas compared to their rural counterparts (World Bank, 2007).

Another system of urban/peri-urban aquaculture in Africa is wastewater aquaculture. The wastewater usually contains domestic waste, including night-soil, that is used to fertilize the aquaculture pond after preliminary treatment. This involves a series of decomposition processes where bacteria, phytoplankton, zooplankton and invertebrate detritivores find their place in a complex micro-food web. In this scenario, phytoplankton or zooplankton provide nutrition for the fish. Wastewater aquaculture has a long tradition and has been practiced in sewage treatment ponds in Kenya, Malawi, South Africa, and Zimbabwe during the second half of the 20th century (Bunting, 2004). More recent examples using direct wastewater for aquaculture in Africa can be seen in Ghana where sewage treatment ponds are used to grow common carp (*Cyprinus carpio*) and mango tilapia (*Sarotherodon galialeus*). This is the case in some residential areas in Nigeria (Bunting, 2004). The reuse of wastewater for aquaculture is a viable option when looking for new water sources in water-scarce regions (Tenkorang et al., 2012), particularly in urban/peri-urban areas. In addition, valuable nutrients are recycled instead of being discharged into the environment, thus reducing the risk of eutrophication (Liu et al., 2010). However, wastewater may contain health-disrupting compounds such as hormones, disease-causing bacteria and harmful chemicals (Asem-Hiablie et al., 2013) that are an emerging challenge for public health. Another obstacle is the potential aesthetic unwillingness among consumers to accept products cultured in wastewater, even if the products are relatively safe. However, there are guidelines for the use and treatment of wastewater for reuse in aquaculture (WHO, 1989; WHO, 2006), as well as for agriculture in general that are applicable to aquaculture (The Hyderabad Declaration, 2002).

TRENDS

In Asia, urban markets for aquatic products appear to have been the major stimulus to development of aquaculture (Little & Bunting, 2005). This may also be the driver for future development of urban/peri-urban aquaculture in Africa as a result of the need to be close to nutrients, markets and

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information (Olaniyi, 2012). Rising incomes in urban Africa and international demand for shrimp and whitefish, such as tilapia and catfish, create further opportunities. Once established, a common development in urban aquaculture in Asia has been intensification in addition to shifts to higher value and/or air-breathing species to improve returns from land, water and capital (Little & Bunting, 2005).

Rapid developments in seed production, fish feed technology, disease control, and the integration of aquaculture in both urban and rural economies are among the innovation domains driving aquaculture expansion. Recognition of the potential contribution of aquaculture to ecosystem services is of great benefit. This can be ameliorated by the emergence of national and international norms, codes of practice, and standards for environmentally friendly aquaculture and healthy fish products. All these have the potential to create further opportunities for expansion.

The integrated production of fish (aquaculture) and vegetables (hydroponic cultivation) with a continuous flow of water and minerals (aquaponics) is a promising farming approach with the potential for a sustainable agricultural system in urban/peri-urban areas. Plants utilize the nutrients to produce a valuable by-product, while the plant bio-beds prolong water re-use by acting as bio-filters that reduce discharge into the environment. This eventually minimizes the use of nonrenewable resources, thus providing economic benefits that can increase over time.

Given increasing water scarcity and eutrophication, these types of systems are suitable resolutions for efficient water utilization and recirculation of nutrients. These aquaponic systems are suitable for backyard farming. Although this fish-plant production technology has been used extensively in many parts of the world (Villarroell et al. 2011) only a handful of countries (and farmers) have taken it up in Africa.

OPPORTUNITIES

In most sub-Saharan African countries there are good opportunities for aquaculture given the presence of several water bodies (lakes, rivers, natural ponds) and varieties of fish species that are suitable for farming (Bostock et al., 2010). Coupled with these opportunities, there is a strong fish consumption culture that has been supported by capture fisheries, for example in Uganda, Tanzania, Kenya, and Nigeria (Jagger & Pender, 2001; Olaniyi, 2012). Thus, the prospects for aquaculture in many African countries are, indeed, very good. Urban aquaculture has many linkages with rural aquaculture in regards to movement of products and knowledge, which may lead to relocation from urban to rural areas as infrastructure improves (Little & Bunting, 2005). A large part of the fish-buying community is concentrated around cities; therefore, urban/peri-urban aquaculture in particular, is convenient because of access to information and more readily available markets in and around cities. Stable markets allow for planned production and a foundation for further investment. Access to government services for extension and research is also easier in and around cities, as is access to export channels. Service industries and labourers, which are often more educated compared to rural areas, are more available; additionally, infrastructure such as power, water, and transport networks are more existent in the cities. Moreover, the higher amounts of background natural food levels in urban/peri-urban areas, compared with more nutrient limited rural areas, can make these systems more productive and sustainable. Since feed availability is a major constraint to aquaculture in developing countries, peri-urban aquaculture can benefit from local waste; there are often strong linkages between development of urban aquaculture, available waste, and wastewater reuse (Little & Bunting, 2005). Transforming animal wastes into fish feed, utilization of industrial waste (from breweries for instance) and reuse of wastewater are potential strategies that will contribute to re-circulation of nutrients and decrease of eutrophication (Nuov et al., 1995; World Bank, 2007).

CHALLENGES/OBSTACLES

Africa has several scientists whose work has focused on different disciplines under the realm of fisheries and aquaculture. These disciplines range from the basic to applied sciences. However, efforts at the moment are best described as fragmented at regional, national and even within country levels. Efforts have been made to bring these different disciplines to one platform. At a recent Aquaculture workshop in Uganda in 2013, where researchers and government representatives gathered from Uganda, Kenya, Tanzania, Rwanda, Malawi, Cameroon as well as researchers from the Swedish University of Agricultural Sciences (SLU), Sweden; it was concluded that there are several challenges and obstacles that are common for a large part of the African aquaculture industry in general. For instance use of unimproved fish strains, unreliable seed supply, and lack of good-quality feed. For commercial feed, the nutritional value is a problem; protein content varies and is often much lower than what the producer claims. Moreover, the cost of the commercial feed is often prohibitive for the farmers. Slow growth of farmed fish seems also to be a problem in most countries in the region, resulting in fish of small size-for-age. Small table-sized farmed fish are not competitive against large non-farmed fish. The lack of well facilitated and equipped laboratories that can readily carry out disease diagnosis and related aquaculture aspects is also a common problem. Other challenges that are common are high labour turnover, expensive and unreliable electricity supply, lack of capital to sustain investment in aquaculture, as well as poor dissemination of knowledge and technologies to fish farmers and weak collaborations and networking among actors in aquaculture.

There are some challenges/obstacles that are specific to urban/peri-urban aquaculture. One of them is the multiple uses of urban water bodies and often-conflicting interests. Contamination by faecal bacteria and heavy metals is a problem in densely populated, mixed residential and commercial districts that are common in many African cities (Demanou & Brummett, 2003). Such waters often receive run-off from toilet facilities, as well as from small industries, such as metal shops, plastic factories, leather tanneries, and textile dying plants. A serious constraint to investments in urban and peri-urban production systems is poaching, theft and vandalism (Bunting, 2004). Moreover, labour costs in urban areas are usually high, given the variety of petty jobs.

KNOWLEDGE GAPS

The above challenges and obstacles for aquaculture production form the basis for research themes that can contribute to improving livelihoods and food security in Africa. The efficient operation of urban/peri-urban aquaculture approaches mentioned in this review need rapid developments in seed production, fish feeding and feed technology, disease control, food safety, environmental aquatic health, risk issues, and appropriate management responses. The challenge is to find low-cost and locally available feed ingredients that do not compete with human or animal food sources. There is also a need for more knowledge of fish biology to develop sustainable and environmentally acceptable fish culture systems that can optimize the use of available resources. For the development of efficient aquaponic systems in Africa, optimisation of local conditions is needed concerning both fish and plants using expertise in both aquaculture and horticulture. More research is also needed on the use of waste and wastewater in aquaculture; specifically, more information regarding techniques, disease transmission, and consumer acceptability is required. Furthermore, the social and institutional contexts in which people engage in aquaculture and issues such as resource access, equity, and policy support need to be explored. There is also a need to understand markets in a holistic manner as well as logistics and real returns that are available.

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Poultry – a major source of protein for the poor

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It is generally acknowledged that poultry is a major source of meat for poorer people in Africa as well as globally. Poultry gives a very good output in terms of meat and income with very little input of feed. The most common poultry held by households and smallholder farmers in Africa is chicken (*Gallus gallus domesticus*) (Samuel et al., 2013). In spite of its enormous importance for food, several constraints facing better output of poultry has been recognized. This includes infectious diseases, predators, climatic stress, accidents and, perhaps, a combination of these (Chaka et al., 2013). By far the most important constraint, leading to loss of up to 60%, has in some studies been attributed to infectious diseases (Chaka et al., 2013). It must be mentioned that the exact cause and numbers may vary in different parts of Africa, but many recent publications are pointing to infectious diseases as the major constraint to better output of small-holder chicken in rural, peri-urban and urban settings.

Overview of important diseases in urban and peri-urban production in Africa:

VIRAL DISEASES

A number of viral diseases are often mentioned as constraints to poultry production in African settings such as Avian Influenza (AI), Newcastle Disease (ND), Avian Encephalomyelitis (AE), Fowl Pox (FP), Marek's Disease (MD), Infectious Bronchitis (IB), Infectious Laryngotracheitis (ILT), Gumboro Disease (GD) and Duck Virus Hepatitis (DH) (Sonaiya & Swan, 2004). One of the best known is Avian Influenza, of the so-called H5N1 subtype, that has caused tremendous problems in Southeast Asia and globally during the latest years. In Africa, there are two countries that have had severe problems to date, Nigeria and Egypt. In these countries a number of people have been infected and died. Egypt is one of the countries that has been severely hit by this viral disease. The number of poultry that has been killed or culled are numerous. This scenario is, however, an exception in Africa as a consequence of this very uncommon highly pathogenic AIV. During the outbreak, H5N1 AIV of all types were found through extensive global surveillance. Low pathogenic AIVs of various subtypes (but not the HPAIV) were found in both poultry and wild birds, but the relevance of this in poultry health is poorly studied.

By far the most important of all viral diseases, and the most important infectious disease of all categories, is Newcastle disease, which is considered the major problem in terms of losses of animals. Newcastle disease is one of the most lethal diseases of poultry worldwide. For example, in one study 72% of farmers reported that they had losses due to infectious disease and 35% of these were estimated to be due to NDV (Chaka et al., 2013). The exact numbers of animals were not reported here and, naturally, not confirmed. Nevertheless, ND is recognized as the major problem as far as infectious diseases are concerned. It is caused by an avian paramyxovirus 1 virus (aPMV-1) that belongs to the genus avulavirus, in the family of paramyxoviridae. It has three major variants of different pathogenicity, velogenic (highly pathogenic), mesogenic (moderate pathogenic) and lentogenic (low or unnoticed). The major hallmark of pathogenicity is the so-called cleavage site of the fusion (F) protein, similar to HPAIV. The velogenic strains have a cleavage site consisting of several basic amino acids. This increases the tropism of the virus and the infection becomes systemic (infecting the whole body). The virus has many genotypes and variants within each genotype. Studies in Africa have shown a similar genetic variability and many genotypes appear to circulate in various regions in poultry (Cattoli et al., 2010; Chaka et al., 2013; de Almeida et al., 2013; Mohamed et al., 2011; Samuel et al., 2013) as well as wild birds (Snoeck et al., 2013). Several recent publications have surprisingly pointed out that many of the strains that circulate in seemingly healthy chickens are of the velogenic type (Chaka et al., 2013; de Almeida et al., 2013; Mohamed et al., 2011; Samuel et al., 2013). The reason for this in not easy to explain, but may be partly due to protection by a previous infection by a lentogenic virus, some kind of genetic resistance in the backyard poultry or that the sampling was done prior to clinical signs. These viruses have both the classical hallmark of pathogenicity (cleavage site) and high score of lethality in experimentally infected chickens. Nevertheless, this unfortunate circulation of velogenic strains must be broken if the severe losses due to NDV infection will be stopped or limited. Vaccines are available but not used in backyard settings for economic reasons. However, several commonly used vaccines cannot protect from infection and spreading, only partly the clinical disease (Samuel et al., 2013). Therefore, a new generation of vaccines must be developed that both protects and stops the spreading of diseases of all genotypes that circulate throughout the globe and Africa.

BACTERIAL AND MYCOPLASMAL DISEASES

Chronic Respiratory Disease (CRD) is a complex syndrome caused by *Mycoplasma gallisepticum* in partnership with bacteria (often E. coli), fungi and viruses (often Infectious Bronchitis). Fowl Cholera (Avian Pasteurellosis) is a contagious septicaemia (caused by *Pasteurella multocida*) that is common everywhere among free-range village flocks. Fowl Typhoid (FT) and Pullorum Disease (PD) are egg-transmitted diarrhoeal diseases (caused by *Salmonella gallinarum* and *S. pullorum,* respectively). Pullorum and fowl typhoid complex are both prevalent under free-range conditions. Salmonellosis is usually used to describe infection with any organism of

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the Salmonella group other than *S. pullorum* or *S. gallinarium*. In countries with intensive poultry systems, poultry meat and eggs are a major source of infection for humans (Sonaiya & Swan, 2004). The opposite may be true of family poultry, with humans infecting poultry. Ojeniyi (1984) reported that *S. hirschfeldii* was isolated from cloacal swab samples in fowls and from an adult human male in the same village.

PARASITIC DISEASES

External parasites (ectoparasites) are very common and include: I. lice (*Menacanthus straminens, Lipeurus caponis, Monopon gallinae, Goniodesgigas* and *Chelopistes meleagride*); II. bloodsucking mites (*Dermanyssus gallinae*), which hide in the cracks of housing and can also transmit the bacteria Borrelia, causing fever, depression, cyanosis and anaemia (spirochaetosis); and finally, III. ticks that can produce severe anaemia and, in extreme cases, death due to blood loss. The more important internal parasites are helminths, especially nematodes. Ssenyonga (1982) showed that worms were a major cause of lowered egg production of scavenging poultry in Uganda, the most common being *Ascaridia galli* (Round Worm), *Heterakis gallinae* (Caecal Worm), *Syngamus trachae* (Tracheal Worm) and *Raillientina spp.* (Tape Worm). Also protozoa causing coccidiosis are very important (*Eimeria tenell*a and *E. necatrix*). Surveys in Southeast Asia and East Africa showed that 73 and 47 percent of birds, respectively, had positive faecal samples of *Eimeria spp*. (Eissa, 1987). The presence of the coccidia organism in faecal samples indicates an infection, but not necessarily at a clinical disease level. Like antibody presence in blood samples, it may indicate a degree of immunity. This should not be "treated", as doing so eliminates the immunity (Sonaiya & Swan, 2004).

FUNGAL AND NON-INFECTIOUS DISEASES

Mycotoxicosis caused by *Aspergillus flavus,* which grows on stored feed ingredients, can cause mortality as high as 50 percent. Common adverse effects include immunosuppression, reduced growth in young stock and reduced egg production in hens (Smith, 1990). Aspergillosis, also called airsaculitis, is caused by the fungus Aspergillus, which grows on damp litter or feed. Poultry health is also affected by nutritional and environmental factors, such as insufficient feed or feed deficiencies. A high mortality rate among chicks during the first days or weeks after hatching may be caused by insufficient feed and water. A high mortality in adult birds may be due to nutritional problems such as salt deficiency, but also an excess of common salt (NaCl). Mineral and vitamin deficiencies in general may result in poor growth, low production or death. Vitamin D deficiency causes rickets (bone deformities) in young chicks and a lack of manganese results in deformities of the feet of older chickens. Microorganisms such as *Clostridium botulinum* and *C. perfringens,* both found in soil, liberates potent toxins that result in high mortality (Sonaiya & Swan, 2004).

CASE STUDY OF AN URBAN FAMILY POULTRY PRODUCTION SYSTEM

A poultry production system run by one family consisted of 400 layers in an urban setting in Kampala, Uganda. Its distance to the next closest human living area was less than 50 meters. Profitability was estimated at average 700 Ugx (0.3 USD) per month when spread out throughout the life of the hen. Layers were kept from October 2012 to Sept 2013 and sold at 10,000 Ugx (3,9 USD) at the end of the production period. All the layers were sold on the same day to two people who also sold to vendors/retailers in markets and restaurants. The market for eggs in Kampala was considered as satisfactory without any outside competition, which contrasts the market for broilers in which competition, especially from Brazilian production, was considerable[1]. Out of the 400 layers, 26 died from day 1 to the day of selling. Five died between day 1 and week 2. Four of these chicks showed no clear lesions. One had whitish/greyish mass in the abdomen, attached to the abdominal wall. Four died from falling into the fire pots and 6 were eaten by rats. Four pullets died without signs of disease, but had swollen and hyperemic caeca with darkish or brownish contents and suspicion of coccidiosis. Thereafter, amprolium was introduced in the drinking water and the deaths stopped. When the amprolium treatment ceased, 7 new pullets fell sick and were removed. Amprolium was re-introduced, after which morbidity was controlled. Additional problems experienced by the owners included the availability and quality of feed. While there are companies that produce good quality feed, there are also many small enterprises that produce poor quality feed. During certain times of the year, especially the prolonged dry period, feed scarcity is very serious/acute, leading to an increase in feed prices by even 100% for some components. The quality of chicks also varies[2]. From the owners' own experience and from discussions with other poultry keepers, they consider coccidiosis as the most serious disease in this type of production. Diseases for which vaccines are available, e.g. Newcastle Disease (ND), Gumboro and Infectious Bronchitis (IB), do not occur if vaccination is performed accordingly. Other diseases to possibly consider are Pasteurellosis, Salmonellosis and E. coli infections. In rural areas with extensive production, ND is considered to be the most devastating.

In September 2013, production was closed for fear of possible closure due to regulations of intensive animal production within Kampala. This was primarily due to the belief of the city authority that poultry farmers added to pollution affecting the public[3]. The owners have plans to start up a new intensive poultry production of 2000 layers about 20 km from the center of Kampala, if the investment can be financed.

CHALLENGES, KNOWLEDGE GAPS AND TRENDS

In summary, poultry is a major source of meat and eggs for many poor people in Africa and globally. The most crucial challenge to handle in production is infectious diseases. The most significant of these diseases is Newcastle Disease (ND). Additionally, zoonotic agents cause other diseases like Highly Pathogenic Avian Influenza (AIV) and Salmonellosis in poultry and, therefore, pose a risk to human health. Presence of these diseases challenges and puts limits for future urban poultry production. Another challenge includes the development of a vaccine that protects against all subtypes of NDV. A trend can be seen towards the increase of intensive production systems outside urban settings as well as an awareness of the importance of biosecurity. Knowledge gaps include improved understanding of low pathogenic AIV subtypes and the role of wild birds as vectors for disease.

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Urban and peri-urban pig farming in developing countries, with a focus on the African continent

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The World Health Organisation reports a big deficit in the supply of animal protein in developing countries. Pig production in the tropics has been recommended as a likely solution to this deficiency, which also provides important sources of income (Ajala, 2007; Kagira et al., 2010; Lekule & Kyvsgaard, 2003). Pigs have high reproducibility with early maturation and a short generation interval as well as high feed conversion efficiency and comparatively small space requirements. Therefore, in many countries it is a governmental goal to promote pig production (Ajala, 2007; Kagira et al., 2010; Lekule & Kyvsgaard, 2003; Muhanguzi et al., 2012; Mutua et al., 2010).

Pigs are commonly kept in urban and peri-urban areas and involve many people through pig farming, marketing live pigs, slaughtering and selling pork. A variety of pig production systems exist, ranging from large intensive commercial pig farms to free-range, traditional small-scale systems (Kagira et al., 2010; Lekule & Kyvsgaard, 2003). However, to increase pig production it is essential to adopt improved practices like disease control, housing, feeding and breeding technologies (Muhanguzi et al., 2012). The main limitations in pig production have been identified as parasites and diseases; high costs of inputs, such as feed; inadequate capital input; feed scarcity; space limitation; inadequate advisory services; lack of good quality breeding stock; poor and unorganized marketing; conflicts with neighbours; expensive veterinary drugs; and uncontrolled pig movement (Kagira et al., 2010; Karimuribo et al., 2011; Katongole et al., 2012; Muhanguzi et al., 2012). Intensive swine production is viable in large cities because of availability of industrial by-products and proximity to markets; nevertheless, 65–80% of pigs are kept in the traditional way (Lekule & Kyvsgaard, 2003).

DISEASE CONTROL

In the central region, pig farmers are often specialized and buy piglets from several sources to fatten them for slaughter or sell them for breeding purposes (Kagira et al., 2010; Karimuribo et al., 2011). The maintenance cost for sow keeping is high and few farmers keep boars, which are also rented out to other farmers (Kagira et al., 2010). Several critical diseases are spread because of trading and movement of pigs; this includes the practice of letting pigs roam around, scavenging in their surroundings. Important factors in the spread of diseases are associated with poor sanitation and hygiene, poor methods of pig husbandry, lack of proper meat inspection and disease control measures at slaughter (Phiri et al., 2003). Diseases such as cysticercosis and salmonellosis are common and pose a serious risk to public health (Ikwap et al., in press; Phiri et al., 2003). The "silent carriers" constitute a specific risk in the transmission of diseases by direct pig-to-pig contact, for example, viruses that can be transmitted by semen. Several zoonotic infections may cause severe diseases in humans, including leptospirosis, brucellosis, tuberculosis, Japanese B encephalitis, trichinosis, cysticercosis, and salmonellosis (Phiri et al., 2003). Other epizootic diseases, such as African swine fever (ASF), classical swine fever, foot and mouth disease and Aujeszky's disease, are of large economic importance. Also, endemic diseases may be devastating because of their high prevalence and contribution to low productivity (Wabacha et al., 2004). Several of these diseases may be spread by the use of fresh pork and slaughter wastes for feeding (Katongole et al., 2011). In surveys, most farmers reported experiencing disease problems among their pigs, most commonly parasitic diseases such as helminthosis, cysticercosis and ectoparasites, ASF, respiratory diseases, hind limb paralysis, abortion, diarrhoea, skin necrosis, gut edema, ear necrosis, loss of claws, unthriftiness, nutritional deficiencies and high mortality rate of unknown aetiology (Kagira et al., 2010; Karimuribo et al., 2011; Muhanguzi et al., 2012; Phiri et al., 2003; Wabacha et al., 2004). For several diseases diagnostic tests and effective vaccines are available. There is, however, usually little investment in animal health, as costs for veterinary services and drugs are considered high (Muhanguzi et al., 2012). Instead, farmers rely on other farmers or sales-people for advice and guidance regarding drug choices. Cheap anthelminthics or alternative medicines, such as local herbs and fish extracts, may be used (Kagira et al., 2010).

HOUSING

Building materials that allow for the confinement of pigs during the entire production process are expensive. Instead, pigs are kept in tree shades or local mud and wattle houses made by available cheap materials, such as reeds, mud and straw (Kagira et al., 2010; Muhanguzi et al., 2012). The shelters often have a mud floor that is rarely cleaned (Kagira et al., 2010) or, in some cases, a raised floor made of wooden materials (Karimuribo et al., 2011). Pigs can easily escape from such enclosures and roam around, increasing the likelihood of disease transmission and destruction of crops (Muhanguzi et al., 2012). Pigs may also be free ranging during the dry season and tethered during the rainy (crop) season. Only a few farmers keep pigs permanently indoors (Kagira et al., 2010). Improper housing has been identified as a major constraint in pig production (Karimuribo et al., 2011). A suitable piggery should have protection against environmental stress, good sanitation, good hygienic conditions, sufficient space, and minimal feed waste, while being as cheap as possible (Lekule & Kyvsgaard, 2003).

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FEEDING

A pig diet is commonly based on various by-products generated from crop/food production (residues after harvesting crops), processing/preparation (peelings, leaves and stalks), marketing/distribution (market crop waste) and consumption (food leftovers) (Katongole et al., 2011; Katongole et al., 2012; Phengsavanh et al., 2010). In addition, diets may contain by-products from abattoirs (rumen content, slaughter waste), dairies (whey) and various food industries (Ajala, 2007; Kagira et al., 2010; Katongole et al., 2011; Muhanguzi et al., 2012). Food leftovers are obtained from homesteads, markets, restaurants/hotels, schools, food processing plants and waste dumpsites. Thus, there are concerns about the risks for both physical (metal, glass, plastic and ceramic objects) and microbial contaminants. In some cases supplementary feed is given, such as protein-rich ingredients and minerals (Karimuribo et al., 2011). A variety of feed resources are often available locally, although the amount may not be adequate and may be of poor nutritional quality (Kagira et al., 2010; Katongole et al., 2012; Phengsavanh et al., 2010). Weaning of piglets at an earlier age would increase profit, but would also require feed of high quality (Kagira et al., 2010). The bulk of carbohydrate and protein content of pig feed is obtained from maize, soya beans and fish. These ingredients are also the source of carbohydrates and proteins for humans, thus, decreasing the availability as a source of feed and increasing the cost. Therefore, feed is often the single most expensive input in pig production and is associated with substantial price fluctuation. Diets consisting of maize and sorghum will only provide approximately 30% of the requirements of certain amino acids; thus, scavenging may have nutritional benefits (Lekule & Kyvsgaard, 2003). Additionally, in many countries water scarcity is a major problem and water may be provided from local rivers and lakes (Kagira et al., 2010; Muhanguzi et al., 2012).

PIG BREEDING

Pig production is often based on more or less "ad hoc" crossbreeding with indigenous breeds whose production potential is lower than the exotic "western" crossbreds, based on Landrace, Large white, Hampshire and Duroc breeds. These exotic crossbreds are often named by their commercial name, given by the commercial company they emanate from. The improved pig breeds have a higher production potential (ILRI, n.d.; Kagira et al., 2010), but need also a higher quality/quantity of feed than what is offered to local breeds. Thus, they may not adapt to the extensive production environment that exists. Also, the accessibility of exotic breeds is limited as the cost of them is considered high and accessing loans is difficult. This might result in the purchasing of exotic and expensive breeds to be used far too intensively, increasing the risk for inbreeding (Kagira et al., 2010). The majority of farmers purchase their breeding stock from other farmers (Kagira et al., 2010; Muhanguzi et al., 2012). The use of village boars combined with unrestricted pig movement increases the risk for transmission of diseases. Artificial insemination is, today, hardly used in small-scale pig production. The indigenous breeds may have valuable traits such as disease resistance and low demands for feed quantity/quality. Further, they survive under stressful environmental conditions, such as high disease incidence, poor nutrition, and high ambient temperatures, that will form a basis for low-input, sustainable agriculture (Lekule & Kyvsgaard, 2003).

TRENDS

The majority of people involved in livestock farming are women (Katongole et al., 2012; Phengsavanh et al., 2010); however, it is commonly the male head of household that is responsible for decision-making regarding pig production (Mutua et al., 2010). The importance of undertaking actions to involve women in decision-making has been recognized. Traditional production systems are regarded as wasteful and unprofitable; however, in Africa, intensive pig farming seems to be stagnant and the traditional sectors seem to be more sustainable (Kagira et al., 2010). Feed scarcity and disease are major constraints for the development of pig production in both urban and peri-urban areas (Katongole et al., 2012) as well as in rural areas (Phengsavanh et al., 2011). Competition of land for other purposes than agriculture is likely to increase the risk for feed scarcity in urban and peri-urban areas. Possibly, this will force production to gradually move to more rural areas with available land at lower costs. Improper feed formulation resulting in nutritionally inadequate diets is common, as is the occurrence of adulterated feed ingredients (Katongole et al., 2012).

OPPORTUNITIES

It is recommended that smallholder farmers form cooperative groups that would allow them to bargain for better feed and pig prices, seek better markets and increase the possibility of access to governmental micro-loans (Mutua et al., 2010). Future research should focus on the integration of smallholder farmers into the country's market chains. Further, access to quality extension services should be improved (Kagira et al., 2010).

It would be desirable to provide institutional support to ensure proper control programmes in meat inspection, slaughter hygiene and information on preventive measures to combat the spread of diseases such as cysticercosis and ASF (Lekule & Kyvsgaard, 2003). To minimize the risk for spread of these devastating diseases, it may be necessary to raise pigs in confinement, thereby excluding the possibility to roam around (Lekule & Kyvsgaard, 2003; Mutua et al., 2010; Phiri et al., 2003). In some countries, it is possible to buy boars from local government-owned trade centers. The possibility to set up breeding centres to provide health-controlled replacement stock at subsidized rates should be explored to decrease the spread of diseases by the uncontrolled movement of pigs (Kagira et al., 2010). In a more distant future, it would be desirable to increase the use of AI and to adopt the concept of quarantines. A further strategy would be to design and disseminate simple, relevantly designed pig houses suited to, and affordable for the poor rural population to control the spread of diseases (Lekule & Kyvsgaard, 2003).

It is necessary to develop feed strategies based on cheap, locally produced feed stuffs (Lekule & Kyvsgaard, 2003). The concept of feed conservation seemed entirely new to most of the farmers in Kampala, Uganda (Katongole et al., 2012). A similar situation is prevailing among resource-poor farmers in other parts of the world (Phengsavanh et al., 2010; Phengsavanh et al., 2011). The implementation of proper feed conservation techniques should make it possible to safely store feed surplus and, thereby, better cope with feed scarcity to the benefit of animal health and performance.

Improved pig breeds will yield higher cash revenue, but will also increase economic risk for the farmer because of the higher maintenance costs (Kagira et al., 2010). Breeding traits that are optimal for marginal environments should be identified and well-controlled trials should be preformed to provide knowledge on the advantages/disadvantages of using genetic material from exotic pig breeds. Irrespective of the outcomes of these trials, local breeds should be genetically characterised and preserved as genetic resources (Kagira et al., 2010). The use of crossbreds might preferably be used in commercial and large-scale enterprises, whereas the indigenous breeds might be better suited for smallholder farms (Lekule & Kyvsgaard, 2003).

KNOWLEDGE GAPS

The presence and prevalence of various diseases is largely unknown. As a first step, it is important to identify the causes of mortality in piglets so that measures can be undertaken to increase piglet survival, thereby improving production (Ikwap et al., in press; Wabacha et al., 2004). Further, the occurrence of various diseases must be defined to provide a list of targeted investigations and measures that will need to be undertaken in future studies on prevalence, routes of transmission, et cetera.

Livestock farmers use several indigenous criteria to judge the nutritional quality of available feed resources (Lumu et al., 2013; Phengsavanh et al., 2010), which includes disease resistance, feed intake, growth/body condition, hair coat appearance, faecal output and texture, and level of production. Despite this, farmers put more importance on availability and cost as opposed to nutritional quality when choosing feed resources. Thus, there is a need to sensitize farmers on the importance of nutritional quality to ensure better feed utilization, improved disease resistance and pig performance.

Indigenous pig breeds need to be genetically characterized to secure the maintenance of valuable local traits; additionally, well-controlled trials should be performed to provide knowledge on the advantages/disadvantages of using genetic material from exotic pig breeds.

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Prospects for small ruminant production in cities – more than the poor man's cow

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Small ruminants (goats and sheep) are suitable livestock for production systems with limited resources, such as urban and peri-urban livestock production of milk and meat.

The suitability of small ruminants in urban and peri-urban agriculture (UPA) is owed to their small size in addition to a set of other characteristics: they require little space, low feed and low initial cost compared to large ruminants; their milk is widely appreciated for human nutrition (Haenlein, 2004); they have a high ability to utilize low quality feeds and survive even after prolonged periods of severe feed scarcity (Silanikove, 2000); they have a short generation interval and frequently deliver twins or triplets (Peacock, 1996; Knights and Garcia, 1997); they can give at least three births in 2 years; they can serve both the rich and poor alike (Peacock, 1996); and their meat has virtually no religious or cultural taboos.

TRENDS

Generally, population trends of small ruminants in developing countries over the last three decades shows a significant increase. The increase is attributed to their special characteristics as well as rising interest and demand for their products (meat and milk), which has amplified their role in the livestock sector. According to FAO – Livestock sector briefs (2005), mutton and goat consumption in East Africa (Uganda, Kenya and Tanzania), West Africa (Ghana, Nigeria and Senegal) and South Asia (Bangladesh, Nepal and India) was estimated to grow at average annual rates of 1.9, 4.6 and 2.8%, respectively.

An interesting trend during recent years is an increase in a supportive legal environment for urban and peri-urban agriculture. Many cities in developing countries, such as Kampala in Uganda, have changed their official attitudes towards urban and peri-urban agriculture from one of hostility to one of acceptance (Katongole et al., 2012). This is an important shift in how authorities consider agriculture and animal production as a significant element of economic growth. For many years, urban livestock keeping activities were defined as illegal or not of concern to the city. The prevailing laws worked against it, while studies and documentation about its existence were minimal. City authorities and state officials considered it an illegal practice, economically insignificant and a threat to public health.

OPPORTUNITIES

The most important drivers for opportunities of urban and peri-urban small ruminant production are: (i) rising interest and demand for small ruminant products (meat and milk), (ii) special characteristics of small ruminants, and (iii) conducive environment that a city provides for farmers.

There is an increasing consumer demand for meat and milk in developing countries. As people in developing countries rise above the poverty level and as they become urbanized, they tend to eat more animal products. This provides a rare opportunity for urban small ruminant production. Proximity to markets is one of the special opportunities that a city provides for urban and peri-urban farmers. Unlike in the past, products of small ruminants now enter formal marketing system, which correctly estimates the contribution of urban small ruminant production to the national economy.

Small ruminants have a potential role in social development programmes. Many social development initiatives in the developing world, by Governments, NGOs, politicians, researchers etc., have recommended the introduction of small ruminants to urban and peri-urban resource-poor farmers because of the special characteristics and benefits described above.

Low quality feed resources are a key component of urban and peri-urban livestock feeding. Since small ruminants have a great ability to utilize poor quality feeds, urban and peri-urban small ruminant production provides a good opportunity to address waste management and nutrient recycling challenges faced by many cities in developing countries.

Small ruminants are less demanding in terms of labor and can easily be managed by all family members, mainly women and children. Their small size makes them ideal for slaughter for family consumption; they can be regularly milked for small quantities of milk for home consumption and they can easily be sold for cash in times of urgency, such as sickness, death or payment of school fees.

CHALLENGES/OBSTACLES

Although, urban and peri-urban small ruminant production plays a positive role in food security and income generation for the urban poor in developing countries, it faces some challenges, which include social contempt. That is, in some countries there is propaganda that people who keep small ruminants are of low status. Following this, there is also a lack of access to extension service, training courses, and vaccination campaigns; similarly, this type of food production is given low importance by authorities.

The scavenging in streets and other urban environments by small ruminants in UPA increases the risk of injuries and may also contribute to degradation of the physical environment in cities. Finally, as for all animals in UPA, they constitute a risk of transmission of infections to humans. Controlling such infectious diseases are particularly difficult in UPA as most animals are not

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confined, but scavenge or use communal pasture areas, resulting in a lot of contact between animals (Lindahl et al., 2013).

KNOWLEDGE GAPS

Generally, there is a lack of reliable data on the production levels of small ruminants in UPA and their economical significance. Hence, it is not possible to assess the contribution of small ruminant production to the aggregated supply of all livestock products in the cities of developing countries, especially compared to large ruminants. Such data is critical for an informed discussion about policies for small ruminants in UPA.

Also, there is a lack of knowledge about adaptation of husbandry practices for specific urban conditions; this is true both for production and public health aspects. For instance, scarcity of feed is a major problem in urban animal production and, thus, farmers feed animals feeds of low nutritional value resulting in low growth performance. It is of importance to find more sustainable feeding strategies to improve urban livestock production. At the same time, urban small ruminants reduce the organic solid/liquid waste streams in cities and a quantification of these environmental benefits would be an important element in the discussion of the pros and cons for small ruminants in the city.

Finally, the fact that many cities are experiencing significantly increasing minimum temperatures and other extreme weather events, there is a need to understand the potential impact of climate change on urban small ruminant production vis-à-vis large animal production.

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Dairy in peri-urban farming for food security and income

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Global dairy production must increase. Dairy products have a high nutritious value and a steadily growing demand. The only sustainable way forward is to "close the efficiency gap" by increasing production efficiency, according to the Global Agenda for Sustainable Livestock (2013). Improved dairy cow health and nutrition will result in higher production using fewer resources, with less negative environment impact.

Within urban and peri-urban livestock rearing, dairy cattle are the most important, even though they need more space and feed compared to smaller livestock. There is great potential for urban and peri-urban dairy production to contribute to food security and family income by creating job opportunities, as long as some deficiencies are dealt with. According to socio-economic studies performed in Burkina Faso (Thys et al., 2005), Tanzania (Kivaria et al., 2006) and Ethiopia (Ayenew et al., 2011), access to certain services such as technical knowledge transfer, strategic cattle breeding with artificial insemination, veterinary health services and credit services are required. Existing limitations include shortage of land for grazing cattle and feedstuff production, manure management, and access to market sites. A threat that cannot be neglected is the spread of endemic animal diseases as well as zoonotic diseases that affect both animals and humans in urban areas with high animal density and close contact between animals and human settlements (Omodu et al., 2007; Kagira et al., 2010).

Most of the milk produced in developing countries comes from small-scale dairy farms. A change in their mindset towards market-oriented production would be beneficial not only for the family's livelihood but for food security in general (Bennett et al., 2006). Cattle owners, compared to farmers rearing other animal species, are more prone to adopt modern innovations, management technologies and practices; similarly, cattle are prioritized before other species in prophylactic health care and veterinary treatments (Amadou et al. 2012). It is also apparent that cattle keeping in cities is more market-oriented compared to traditional, rural cattle farming (Ayenew et al., 2011; Kagira, & Kanyari, 2010). It is noteworthy that urban dairy farmers are not a homogenous group as they differ in education level, experience in dairying, and economic situation, for example; they also face different conditions depending on political regulations, access to services and training.

TRENDS

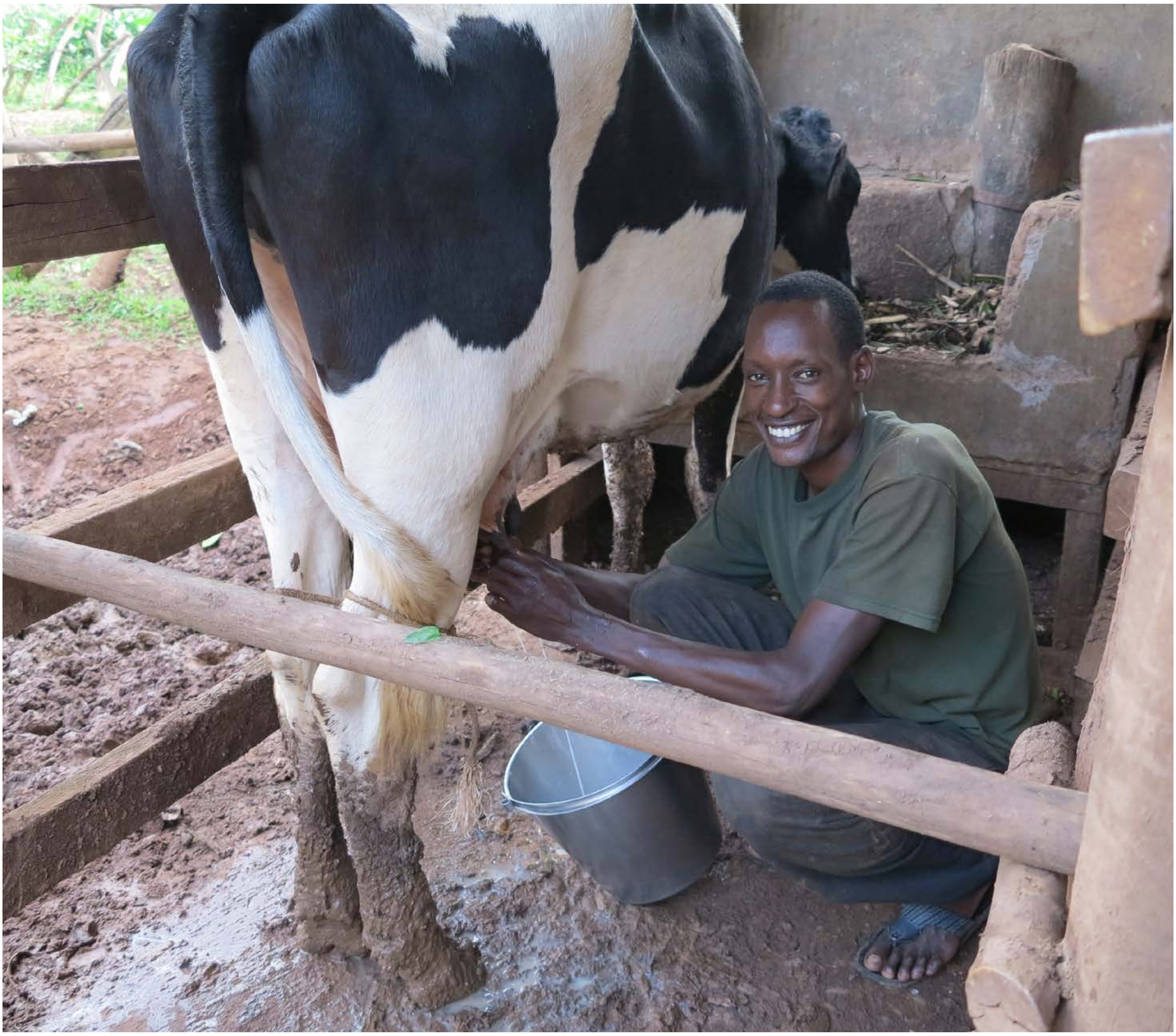
In developing countries, small holder dairy farms are predicted to become chief contributors of milk and meat, meeting the demands from an increasing urban population. Dairy farmers' orientation is changing from subsistence production to commercial engagement with higher profit, better animal welfare and food security. However, medium-sized or large commercial farms are dependent on arable land and pastures, driving them further afar from urban markets by growing cities. Urban farms are often low-input units run by opportunistic smallholder farmers with little farming experience.

OPPORTUNITIES

Most of today's dairy production comes from low-intensive smallholders. Changes in the farmer's mindset and practice will rapidly increase production. Dairy production is market-oriented, which is a highly motivating factor and driving force for the farmer. Urban dairy farming also contributes to an increase in employment and to the start of other businesses related to the dairy industry. Additionally, fast growing sectors in veterinary services, milk collection and processing markets are valuable for national economic growth.

CHALLENGES AND OBSTACLES

In many areas there is a lack of knowledge, attitude and dairy management practices among dairy farmers, extension service personnel, veterinary practitioners and policy makers. The infrastructure is inadequate for dairy product value chains and access to markets. There is limited access to land for feedstuff production and grazing in urban/periurban areas; this leads to feed scarcity, but also poor feed efficiency with nutrients being wasted. Endemic disease prevalence is high in urban areas. Zoonotic diseases pose a risk for animal and public health. Due to constraints in nutrition and health, calf mortality is high and fertility is low. There is a lack of strategic breeding programs and insufficient recording of cow or herd performance. Dairy breeds currently used, both indigenous and exotic, are not performing optimally. There is a need for selection and development of suitable breeds, in addition to a need to feed and manage indigenous breeds to be able to reach their genetic potential. Handling of manure and feed waste is suboptimal. This increases the risk for spread of disease and, to a great extent, pollutes the urban area instead of being beneficial as fertilizer in local cultivation.



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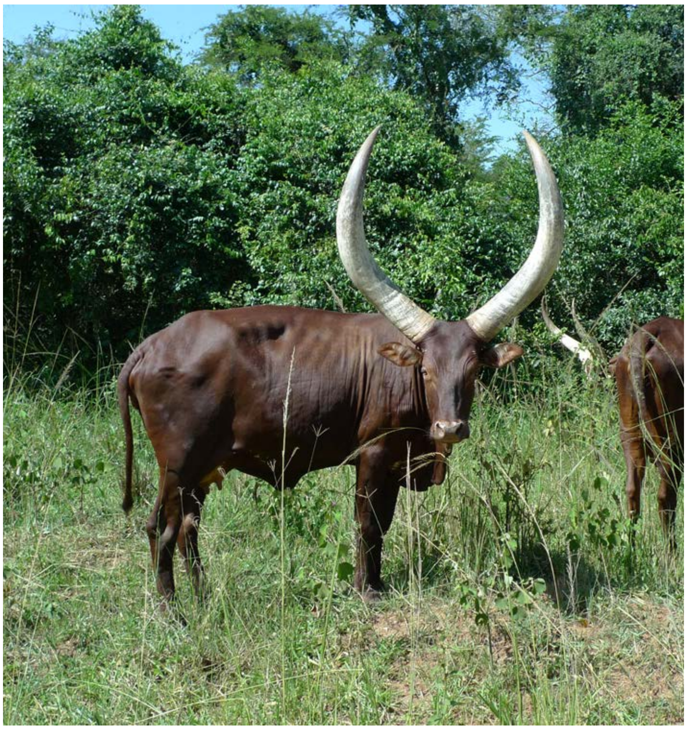

KNOWLEDGE GAPS

There is a specific lack of knowledge on how to provide for the cow's nutritional requirements in urban production systems. Farmers tend to feed animals erratically with whatever they can find, including feed that is nutritionally insufficient for the cows' production needs. It is important for urban dairy cow owners to be sufficiently knowledgeable about nutritional requirements in different stages of the milk production cycle and how to fulfill this. Critical periods that require specific nutritional attention to ensure productivity of the cow are the non-lactation (dry), calving and early post-calving periods. The cow is facing metabolic challenges after calving when she is initiating new lactation as well as preparing the reproductive system for the next breeding. It is important to find and customize appropriate and sustainable feeding strategies to improve urban livestock production, while taking care of environmental concerns.

Research is proposed on nutritive content and adverse effects of feed resources commonly used in urban dairy herds, with determination of appropriate feed and feeding combinations for specified levels of production and physiological states for sustainable and acceptable performance.

PHOTO: RENÉE BÅGE

Interactions between dairy cow phenotype, genotype and environment need to be studied to find an appropriate robust, healthy and fertile cow breed with an acceptable milk production level for the prevailing conditions and markets. Research is proposed on performance-based dairy cow genotypes and their combinations for the customized dairy product markets in particular urban livelihoods. The 'appropriate performance' should be based on available feed resources and other support and back-up services such as animal health, breeding etc., to ensure sustainability.

Contagious diseases need to be studied from several aspects: prevention of disease emergence and spread, risks for public health, development of antibiotic and anthelmintic resistance, impact on farm economy etc. For a sustainable farm economy, the fresh milk produced in urban herds must adhere to certain milk quality requirements for increased shelf life and industrial processing of various dairy products for market.

More research is needed on endemic zoonotic diseases among dairy cows in urban production systems. Studies are urgent for improved udder health and milk quality and for reduced use of antibiotic treatments in dairy production. Investigations are needed on residual contaminants of human food produced from milk or meat from urban dairy cows. Other research topics are engineering and designs for infrastructure (housing, drainage and manure disposal) to ensure bio-safety from environmental pollutants from urban dairy herds.

For good management and cow welfare, basal recording of current practices, management, milking techniques and performance is needed with the aim to suggest relevant changes in practices for improved health and production efficiency. Herd health programs need to be developed based on current knowledge, but also adjusted to different production systems. Standard guidelines need to be proposed for dairy cow health and welfare in different urban livelihoods. In connection, there is a need for development of appropriate software and collection of essential data for monitoring management and productivity of dairy herds within urban livelihoods.

Finally, multidisciplinary research groups need to scientifically study the process of knowledge transfer, changes in the farmer's mindset, and implementation of new practices, focusing on entire value chains in dairy production.

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Concluding remarks and research needs

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Increased immigration into urban centers in the recent past was largely due to expectations of better lives in cities across the world, especially by unemployed youth. This coupled with general expansion of the population in Africa has caused immense pressure on food security and incomes of urban and peri-urban dwellers. This is exacerbated by low wages paid to both public servants and those employed in the private sector, even though recent reports suggest an expansion of the middle class. In order to meet these needs, there has been an expansion of urban and peri-urban agriculture to produce 15–20% of food consumed globally. The focus in this anthology is on sub-Saharan Africa, but experiences from other regions of the world are also included. Similarly, the ones presented here may be applicable elsewhere.

The major driver for this type of agriculture appears to be the need to meet individual household food requirements and as an income generating activity by selling to other urban dwellers. However, the individual urban farmers´ motives relates to domestic and export markets as well as to the organization of various value chains. Also, the balance between, and importance of, UPA for income generation and subsistence of food varies by gender, wealth and area of residence. Obviously, the issues for UPA also vary by these settings. There is limited information about the contribution of UPA to the export market.

The importance of UPA cannot be overlooked. Farmers are engaged in various enterprises involving crops (especially fruits and horticulture crops), dairy and small ruminants, pigs, poultry as well as aquaculture. Products from these enterprises provide urban dwellers with more food that is also of a higher nutritious quality to meet their health and growth requirements. Furthermore, UPA improves a household's security in times of uncertainty through having access to more stable food sources.

While each of these enterprises comes with their own opportunities, the challenges facing production systems have also been clearly identified. Specifically, they include chemical and microbial hazards in horticulture diseases of livestock, shortage or unavailability of low cost feed products, lack of technological knowledge on various aspects of aquaculture production, as well as environmental and health concerns arising from poor waste management systems, to mention a few.

Land access remains a major factor in urban and peri-urban production systems with a clear gender dimension and the uncertainty of land rights is an obstacle for long-term farming strategies. Land is becoming largely expensive and unavailable, leaving it to the rich who use it for capital developments and not agriculture. There is a need therefore to use intensification methods where more is produced from less land. This calls for use of fertilizers in crop production to increase land productivity as well as intensified poultry, piggery, small ruminant animal and dairy production methods; for example, the use of crop wastes to feed animals makes for a more efficient UPA system.

Environmental and human health concerns take centre stage and have been a source of conflict between city authorities and urban farmers. Several of the current farming and handling practices contribute to negative environmental externalities. Similarly, there are many diseases and pathogenic agents that can find their way into the food chain and cause harm to humans, for example via vegetables, eggs and milk. Hence, it is crucial to further explore the options to reverse the negative environmental impact and how to control the spread of pathogens in UPA.

Consequently, waste management has also been raised as an important area that needs to be addressed. All of these production systems generate waste and wastewater that is not fully collected and treated, resulting in major impacts on the environment and health. There is need to develop low cost and simple treatment systems resulting in safe end products.

With increased population growth, the highest being in sub-Saharan Africa, and persistent poverty and hunger in rural areas, migration into cities and other urban centers is going to continue growing; this, in turn, creates more need for food. Here, each chapter has identified and highlighted challenges and opportunities that are associated with various aspects and production systems with regards to UPA. Furthermore, knowledge gaps have been established in order to come up with policies to place UPA in the right position to contribute to both economic and social well-being of urban and peri-urban dwellers. Going forward, there is need to design studies to provide information for policy development. Such policies would recognize that there are advantages accruing from UPA that comes with associated risks to the environment as well as both animals and humans, which need to be monitored and managed.

Overall, the current scientific literature regarding UPA has its shortcomings. For instance, the gender aspect is biased towards horticulture rather than livestock; most studies are single-city studies and there is obvious need for cross-country analysis; and, finally, studies in low-income countries are clustered to certain areas. The identification of these and other gaps presented here will enable scholars to design researchable interventions, including policy development, to allow for UPA to make a significant contribution to both food security and human well being.

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By 2050 it is estimated that the global population will reach almost 10 billion, with the majority of that growth taking place in urban areas of less developed regions of the world. Such rapid urbanization has produced a large group of urban poor, proliferating widespread issues like food insecurity and malnutrition in low-income countries.

Urban and peri-urban agriculture has evolved as way to mitigate these challenges and offers a variety of benefits such as improved food security, food of higher nutritious value, and greater household incomes. It also enables the urban poor to better withstand spikes in food prices. On the other hand, this type of agriculture increases the risk for the spread of diseases from animals to humans and creates sanitary and environmental problems related to waste, water and manure.

Here we present science-based information on drivers, pros and cons, and knowledge gaps related to urban and peri-urban agriculture in low-income countries. We believe that this information will be of interest for scholars and policy-makers alike and others working for global food security. The anthology is written by researchers from three Swedish and two Ugandan universities with financial support from the Swedish Ministry of Foreign Affairs as part of its special allocation on global food security.

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