

Issues and options for crop-livestock integration in peri-urban settings

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Summary

Livestock production, especially small livestock and dairy production, in peri-urban areas is a fast growing industry. This is due to the growing demand for animal products as urban populations increase and their diets shift to include increased consumption of animal products. On the other hand, urbanisation is also generating a rapid increase of organic biomass in urban areas. These situations create an opportunity for the introduction of an efficient crop-livestock integration model in peri-urban settings to improve nutrient recycling in the urban, peri-urban and surrounding rural areas. However, in order for an efficient crop-livestock integrated system to develop, there must be an enabling policy environment, to facilitate investment in infrastructure and coordinate logistics for biomass collection and use.

Introduction

One of the characteristics of urbanisation is the change in diets of the population. The increase in income is driving the shift to increased consumption of animal products. Because of this market opportunity, livestock are often produced in peri-urban areas where poultry, dairy and pig farming can be found (Figure 1). The commercial peri-urban production of livestock is an extremely fast-growing sector, representing 34 percent of total global meat production and nearly 70 percent of egg production.

Poultry, pig, dairy and small livestock (such as guinea pig and rabbit) production can be also be found within the city limits. While these activities are located near to consumers and are thus advantageous for market access, there are several concerns that arise precisely from their proximity to densely populated areas and the dense concentration of animals in small areas. Firstly, there is a concern over environmental pollution that can be caused by various emissions and

discharges from animal production. If animal excrement and other waste are not properly managed, they can pollute the water source or air in and around cities. Manure produces a large amount of various gases in the process of decomposition, including hydrogen sulphide and ammonia, that can cause severe sickness at high doses. Another environmental concern is the smell or noise caused by livestock production that may not be acceptable for neighbouring residents. The leached nitrogen (N) from manure can be converted to nitrate in the soil which, when leached into water channels, can cause health issues especially in children. Similarly, when phosphorus (P) from faeces contaminates water channels, it can cause algal blooms which decrease levels of dissolved oxygen in the water, adversely affecting aquatic life. Also, zoonotic diseases can be shared between livestock and humans, avian flu being a typical example, where risks are higher when human settlements and animal production are closely located.



Figure 1. Dairy cows being zero-grazed on the outskirts of Narok, Kenya (Photo: FAO/Ami Vitale)

In cities such as Lima, Nairobi and Bangkok, large-scale commercial livestock production and aquaculture are found in peri-urban areas. This is to take advantage of the economies of scale and to be near the market for their perishable products. However, they can be a source of large amounts of N, P,

potassium (K) and heavy metals like copper and zinc entering the water system. For example, Thachin river (a tributary of the Chao Praya), less than 50 km from Bangkok, was ranked the most polluted river in Thailand from 2000 to 2002. This was a result of contamination by waste water from pig farms and industrial plants.

In some countries and cultures, pastoral systems are found even in urban areas, where livestock is part of the urban landscape. Here, the issue of pollution and health is also present, often affecting the urban poor population living in slums who share the water supply with the animals. In some cities, efforts are made to zone areas for pastoralists, but in many cases they are unregulated or unplanned, and the pastoralists do not have legal access to the lands where they care for their animals (Figure 2).



Figure 2. Herders drive their cattle across the highway in Entebbe, Uganda (Photo: FAO/K Dunn)

Opportunities for raising livestock in peri-urban areas

It may seem, after the problems outlined above are taken into consideration, that livestock production does not belong in the urban or peri-urban contexts. However, if appropriate measures are taken, it can coexist with human settlements, taking advantage of the readily available market, and increasing the efficiency of resource use that is unique to more densely populated urban areas. It can also provide livelihood opportunities for the lower-income population in or near the cities. Peri-urban areas, being at the interface between rural and urban areas, provide opportunities to enhance resource use efficiency in a consortium of these three entities. Some illustrative examples of such systems are given below:

• *Pig raising in Lima*

Pig raising is an important livelihood activity in the district of Lurigancho Chosica which is a low-income peri-urban neighbourhood on the east side of Lima. The municipal government, supported by the work of NGOs in the area, revealed that there were about 1,600 families engaged in pig farming, with an estimated annual stock of 5,000 sows and an annual production of about 60,000 head. When there were disease and public health concerns raised by new residents in the area, the municipality facilitated a meeting between the farmers and the Ministry of Health to address the issues in a

constructive way. Proper regulation and an accountability framework with permits, water quality monitoring and waste control have been achieved with training and appropriate infrastructure development.

• *Animal production in China*

Shunyi district, 30 km from Beijing city centre, produces 43 percent of Beijing's total pig production, or 1.67 million pigs annually. It is known as a dominant region for animal and vegetable production, with 40,000 ha of the district being dedicated to agricultural purposes. Pig farming is one of the major causes of water pollution, and with declining reserves of ground water because of frequent droughts since the late 1990s, soil pollution along the riverside has also been on the increase. In 2000, ecologically friendly pig-vegetable mixed farms were designed and installed. A vegetable packing plant and sewage processing plant were also built to produce biogas using pig urine and faeces. By shifting to the ecological pig-vegetable system, it has been possible to significantly reduce the amount of pollution. The integration can be seen, not only at the individual farm level, but also at district level where pig farms and vegetable farms coexist and the manure is being recycled within the district. While land management laws protect arable land for agricultural use, because of the proximity to Beijing, pressure to convert land to other purposes persists. Construction of an airport and automotive industry development in the area are inducing land use changes. The ongoing changes are seen as an opportunity to grow high value products such as fruits and ornamentals (Kamphuis *et al*, 2004). Animal production is prioritised for its economic value and the production area is expected to increase in the district, while traditional farming, focused on cereal production, is expected to decrease.

Among the three dairy systems in China: smallholder subsistence (<10 cows per farm); cooperatives (>100 cows owned by different farmers but managed collectively); and peri-urban (>100 cows), the peri-urban system was found to be the best managed. It achieves the highest feed conversion efficiency, the highest feed-nitrogen use efficiency, the lowest use of components edible for humans in animal diet, and the highest milk yield per unit feed cost (Wang *et al*, 2014). These results illustrate that good management plays an important role and peri-urban dairy farms, if managed efficiently, can produce high milk yields with low emission of pollutants.

• *Dairying in Punjab state, India*

Punjab contributes approximately 10 percent of national milk production. Some 39 percent of the human population in the state lives in urban areas, and increasing human migration from rural to urban areas has led to increased demand for animal products, especially milk and milk products. The dairy animals have been removed from the big cities in order to keep the cities clean and to alleviate the sewage disposal problem. In order to cater for the demand for dairy products in the urban areas, the government has established seven peri-urban dairy complexes (two each in Jalandhar and Ludhiana; one each in Amritsar, Ferozepur and Hoshiarpur districts). Bakshi *et al* (2010) describe the conditions in these peri-urban dairy complexes as follows:

- Unhygienic, poor cleanliness, heaps of dung on ground and strong smell around the farms.
- The number of animals per unit space is very high and not letting the animals free for exercise raises animal welfare concerns. Poor living conditions could be responsible for the high incidence of mastitis in the milking herd.
- The use of the banned hormone oxytocin at high doses for milk let-down, and use of the same needle for many animals, which might explain the high incidence of abortions (up to 20 percent) in most of the farms.
- The in-house treatment of sick animals and not following strictly the recommended deworming and vaccination schedules.
- Milking of sick animals given antibiotic therapy without taking into consideration the withdrawal period.
- Feeding of unbalanced rations leading to low feed use efficiency and high pollutant emissions per unit of milk production.

All the above mentioned challenges can be overcome through proper training of farmers and enforcing existing regulations, which would contribute to improvements in animal health, welfare, and product safety. The use of proper manure management practices would further enhance the income of farmers and resource use efficiency.

Opportunities for crop-livestock integration

Livestock production in urban and peri-urban areas generates economic benefits as described above. Beyond the economic benefit, there is increasing interest in livestock production as a means to improve biomass management in cities. As the population grows, 'waste' (referred to as 'biomass' or 'resource' in this paper) becomes an increasingly important issue for municipalities. With rapid increases in population, the amount of such resources also grows in parallel. Re-using organic waste as animal feed is an opportunity. Examples are the use of vegetable and fruit wastes from wholesale markets, plants that are discarded in the processing procedure, or simply overstocked fruits or vegetables that do not get used for human consumption (Wadhwa *et al*, 2015). Agro-processing by-products, and wastes produced in the vicinity of cities, also form a substantial part of animal diets in peri-urban areas. These sources not only fill the gap between the required and available feed resources, but also help in mitigating the pollution which might arise due to their decomposition when not used as animal feed. FAO has produced a manual on production of silage and blocks from such organic wastes and industrial by-products for feeding to ruminants (FAO, 2013).

In many countries in Asia, Africa and Latin America, the pigs and poultry in peri-urban areas are raised with waste available from the city, including kitchen wastes, stale bread and tortillas, leftover tortilla dough, chicken guts, and fruit and vegetable wastes. With the rise of animal feed prices and increasing demand for animal protein, recycling of organic waste to animal feed is being tested in various parts of the world. This also includes use of organic waste to rear insects, which will then be fed to poultry or fish (Makkar *et al*, 2014; Tran *et al*, 2015). A challenge in using such biomass as

animal feed is that the safety of the animal feed, animal health and welfare, and the product quality and safety, must not be compromised. The animal waste that is then produced can be recycled back to the crop production in the urban, peri-urban or rural areas.

In many countries, the compost made from animal manure in peri-urban areas has a good market for use in horticulture and floriculture in peri-urban and urban settings; sale of manure can form a substantial part of the income of peri-urban livestock farmers. In some places, the manure goes back to fields in the rural areas which are the main source for food and feed crops, thus helping to reduce nutrient export.

Obtaining resources from both ends (agroindustrial by-products and vegetable and fruit wastes from wholesale markets both within and around cities, and plant resources as animal feed from villages) can contribute to the prevention of nutrient leakages in a broader area context. This also helps to close the nutrient cycle and provide nutrients (through manure) back to villages for crop production and also to peri-urban areas.

The key to enabling this nutrient recycling is policy support from the local or national government to implement a waste collection scheme. In the municipality of Nonthaburi, adjacent to Bangkok, the municipal government contributes by collecting organic waste, which could pave the way for its use as animal feed. Similarly, other cities are addressing the challenge of diverting biomass from landfills, for higher value utilisation. The City of Johannesburg in South Africa, for example, is working on increasing the efficiency of separating waste at source to obtain biomass with the potential for use as animal feed (Nahman *et al*, 2012, City of Johannesburg, 2013).

Lately, innovative crop-livestock integration businesses are being developed in some countries. One of those businesses is *Zoe Biotech*, a company in France that is setting up cactus (*Opuntia ficus-indica*) plantations to incorporate into cattle feed, but also using the cactus pads for rearing black soldier flies to be fed to fish such as tilapia. *Opuntia* (prickly pear) can be used to rehabilitate degraded land, and is now being tested in many places as animal feed, with an extensive production of 400,000 ha each in the northeast region of Brazil and Tunisia. In Brazil, feeding a ration containing 70 percent cactus pads and 30 percent concentrate to cows has been shown to support a milk yield of 25 kg/day. The multipurpose use of prickly pear, as fruit and vegetable for human consumption as well as for animal feed, is gaining interest in countries experiencing worsening drought conditions. The potential to serve urban market needs with the variety of products from prickly pear production, and integration into livestock production, is an emerging industry for peri-urban areas in several countries in Africa and Asia (FAO-ICARDA, 2015).

Conclusions

There is a clear trend of increasing demand for animal products in urban markets. Opportunities for livestock production - mainly poultry, pig and dairy - in the peri-urban areas are being explored and established in many cities and their surrounding regions. However, as they are mainly developed at commercial

scale, the nutrients build up in the soil and water, and as a result pollution and human health issues are prevalent in many parts of the world. However, livestock production in peri-urban areas also gives rise to opportunities to set up crop-livestock integrated models that allow more efficient nutrient recycling and thus decrease the amount of pollution into the water sources and air. Because of the large scale of production, some regulatory measures are necessary, and an enabling policy environment with appropriate investment is key for successful crop-livestock production in peri-urban areas. The pressure on land for competing uses is ever present, so careful consideration of various elements such as consumer demand, environmental impact, economic development and social inclusion and protection is important in land use planning. Efforts and experiences for crop-livestock integration in various parts of the world, and emerging new technologies to support the system, should be shared widely to achieve more sustainable production to support the demands of the rising global population that are increasingly concentrated in urban areas.

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