4. Financial benefits and trade-offs

This chapter explores some of the financial and economic aspects of urban and peri-urban agriculture in Ghana. Cost-benefit analysis comparisons were made of farm finances of common rural, peri-urban and urban farming systems. Some studies also tried to quantify benefits for the society and to cost externalities related to soil nutrient depletion and health impacts from increased urban malaria events and through pesticide use.

4.1 Financial analysis

Urban and peri-urban farmers involved in open space agriculture have little alternatives to using polluted water from streams, drains and dug wells. Only in a few cases do they have access to pipe-borne water and can afford its use. In Kumasi, urban farmers mostly use watering cans while peri-urban farmers often use pumps to convey water from rivers and streams to their farms, which are often farther away from water sources than the plots in urban areas. Due to human limitations on the number and size of cans that can be handled, manual irrigation requires frequent trips to the water source which makes irrigation tiring, time-consuming and labor intensive. Labor for watering accounts for 13% of total cost (excluding family labor) and 38% of time. Even higher percentages are possible in drier areas and sandy soils, like along the beaches of Lomé (Tallaki, 2005). When water is pumped, the cost for hiring pumps is estimated to be from US$ 40-70 per dry season (ca. 3 months). In general, manual labor is more expensive per volume of water delivered (US$ 3-6 per m^3) compared to using pumps (USD 0.6-5 per m^3) (Cornish et al., 2001).

In analysing costs and returns a major factor accounted for was therefore the cost of water, which includes hiring of pumps, cost of labor for watering and other activities. Weeding, which is also labor intensive was rated as the most expensive activity by the farmers accounting on average for about 23% of total cost. Most farmers who use manual labor rarely pay for it as they depend on family labor. They hire laborers occasionally for larger numbers of beds, but rarely pay more than US$ 11 per season.

Though the water used has some nutrients, vegetable farmers also use significant amounts of other types of soil nutrients as well as pesticides. In Kumasi, the use of poultry manure is very common due to its easy availability and low price (US$ 0.2 per sack). Only a few farmers use mineral fertiliser in addition to this (mostly for cabbage). In peri-urban Kumasi, many more vegetable farmers use mineral fertiliser (US$ 14 per 50kg NPK) but combine it with poultry

manure when possible (Drechsel et al., 2004). Variations are related to the crops cultivated by the farmers.

Table 4.1 shows farm income data based on costs and returns as recorded by farmers in Kumasi, Takoradi and Accra. The data correspond with records from other cities in West Africa (Drechsel et al., 2006a). Income varies depending on the type of crop, season, farm size and investments in labor and improved irrigation facilities, e.g. motor pumps.

Table 4.1: Monthly net income from irrigated mixed vegetable farming in Ghana (US$ per actual farm size).

City	Monthly income (US$)
Accra	40-57
Kumasi	35-160
Takoradi	10-30

Comparing different farming systems, the data from the Kumasi study show that urban farmers with access to irrigation water are able to cultivate all year round and can reach annual income levels of US$ 400 to 800 (see Table 4.2). This is twice the income they would earn in the rural setting. However, being successful this way requires careful observations of market demand. The greatest factor influencing farmers' profits is less the yield obtained but producing at the right time what is in short demand and the ability to sell consistently at above average prices (Cornish and Lawrence, 2001).

Table 4.2: Revenue generated in different farming systems

Location	Farming system	Typical farm size (ha)	Net revenue (US$) per actual farm size per year (range)
Rural/peri-urban	Rain-fed maize or maize/cassava	0.5-0.9	200-450 [a]
Peri-urban	Dry-season vegetable irrigation *only* (garden eggs, pepper, okra, cabbage)	0.4-0.6	140-170
Peri-urban	Rain-fed maize combined with dry-season, irrigated vegetables	0.7-1.3	300-500 [a]
Urban	Year-round irrigated vegetable farming (lettuce, cabbage, spring onion)	0.05-0.2	400-800

[a] These are typical values; subsistence production has been converted to market values. In case farmers use parts of their maize and cassava harvest for home consumption, the actual net income would be lower. Source: Danso et al (2002a).

As urban farming is land and labour constrained, typical farm sizes range between 0.05 and 0.2 ha in Kumasi. Comparing the different farming systems, urban wastewater vegetable production in Ghana generates the highest net revenues per hectare. Even with plot sizes that are significantly smaller than in rural areas, urban farmers earn at least twice as much as rural farmers.

An analysis of the different dry-season vegetable production systems in peri-urban Kumasi showed that the combination of pepper, cabbage, tomato, and garden egg yielded the highest profit per hectare among the common peri-urban crop combinations being practiced in the survey area. It was obvious that whenever cabbage was part of the combination, the net profit was high. Cabbage has become a major component of street food and the modern diet of the urban middle and upper class income households (Gyiele, 2002a).

Even though cabbage- based crop combinations were the most profitable crop enterprises, only about 10 % of the farmers around Kumasi engaged in cabbage production. The reasons for this low figure are not hard to find. There is first of all the harsh competition from urban farms specialized in cabbage production. In contrast to urban sites in Accra, the farms in Kumasi have a relatively higher tenure security (university land) and more fertile soils. In addition, cabbage production is very input intensive, especially in view of irrigation and pest control. This entails a correspondingly higher expenditure on labor and plant protection chemicals. This is one instance where, despite high profits arising out of high physical efficiency in production, few farmers are willing to undertake it due to higher investment in cash and time. On the other hand, most vegetables offer a quick cash return. Comparing profit as percentage of production costs, the traditional mixed cultivation with oil palms ranked highest but would require much longer investment periods (Gyiele, 2002a).

4.2 Comparing informal and formal irrigation

Abban (2003) carried out a comparative study between vegetable production in the informal (urban) production sector (Accra city) and commercial irrigation schemes (Greater Accra Region). He interviewed 60 farmers in each system, most of them practicing multi-cropping. The author concluded that the gross revenues were four times higher in formal irrigation schemes but also eight times the (variable and fixed) production costs. The resulting net returns still favoured formal irrigation with an income twice as high as in informal urban irrigation. The benefit-cost ratio in the production period, however, was twice higher in urban

agriculture, making it an interesting venture for migrants trying to establish a livelihood with little start capital and in need of quick returns.

4.3 Socio-economic impact and urban food supply

Urban agriculture can be market oriented, subsistence oriented or serving both purposes. It may be practiced as a sole source of income or to supplement immediate household food requirements and is often carried out alongside other forms of employment (Box 4.1).

Important is to differentiate under the general umbrella of "urban agriculture" between on-plot and off-plot farming, or in other words: backyard gardening and open-space market farming (Table 1.1, Chapter 1). Both contribute to different development goals. While backyard gardening usually serves subsistence purposes and improves farmer's food security, market gardening aims at cash generation and contributes first of all to poverty reduction.

Box 4.1: Wastewater irrigation and livelihoods (three stories)

Accra: Our farmer is a 51-year-old lady, regularly employed as a teacher, who farms part-time at a site using drain water. She is a Christian and is married with five children; she has secondary school education and lives in Osu, one km from the farm. She owns a food-processing machine (corn mill) from which she earns ¢200,000 (about $ 25) per month. She earns the same amount from teaching and her husband, an administrative officer, also contributes ¢200,000 per month. But more substantial is that she can add up to ¢450,000 from her vegetable beds per cropping period, and a crop like lettuce requires only one month. She says "This small piece of land keeps my family in a better status and supports the education of our children".

Kumasi: A 32-year-old female farmer who owns about 30 beds, cultivating mainly leafy vegetables explains: "I am a seamstress but I cannot survive without these vegetables. In most cases, I have to pre-finance sewing of the dress with income derived from vegetable production because it can take somebody more than two months to pay for the cost of the dress. I am getting my everyday expenditure from these beds".

Tamale: ''We started (cabbage) farming many years ago with our parents here. We depend on it. We had to change from wastewater to piped water due to our inability to access water anymore from the drains. Our colleagues are fortunate to have the wastewater still because it makes crops bigger in size and they look fresher and broader than ours. Meanwhile the prices of the crops are the same. We have to pay a monthly water bill while they do not pay anything".

Moving out of poverty: For peri-urban farmers, dry season vegetable irrigation adds 40-50% of cash to their normal income especially as significant parts of their rain-fed maize and cassava harvest are consumed by the household. Without this additional income, cash availability might actually be less than US$ 100 per year. Around Kumasi, about 60,000 people are benefiting from dry-season irrigation (Cornish and Lawrence, 2001). However, only a minority of peri-urban farmers shift to year-round vegetable farming (e.g. tomatoes in the Akumadan area). There are three reasons for this: the importance of maize and cassava for home consumption (mentioned by 52% of the farmers interviewed); the lower price of vegetables in the rainy season (40%); and the increased risk of pest attacks (8%). But those farmers who move to urban areas and take the risk take a remarkable step to overcome poverty. As shown in Table 4.2, urban vegetable farmers can double the maize-cassava income of their rural colleagues and move over the poverty line of one US$ per capita.

Individual food supply: In Accra and Kumasi, the surveys showed that in each city about 600,000 residents from all income categories benefit from their backyard gardens (IWMI, unpubl.). These gardens can be very small (e.g a few plantains). The cultivation for subsistence purposes mainly relieves the household of its necessary budget allocation for foodstuff. Thus backyard gardening does not play a key role in household livelihood strategies regarding food supply, but is part of it and reduces to a limited extent households' vulnerability to food crisis. However, those who have more space and larger gardens or chicken coups, might also sell surpluses. In contrast to backyards, open-space cultivation of vegetables is usually for the market. This is especially the case for exotic vegetables while farmers who specialize in traditional vegetables might also consume a part of their produce.

Urban food supply: At the macro level, the contribution of urban agriculture to the Gross Domestic Product will be small, but the importance for certain commodities, as lettuce, cabbage, milk and poultry products might be substantial, especially if we consider up- and downstream activities (Cofie et al., 2003; Drechsel et al., 2006b). Nugent (2000) reported that urban agriculture can meet large parts of the urban demand for certain kinds of food such as fresh vegetables, poultry, potatoes, milk, fish and eggs. The proximity of production to consumption reduces traffic, (cold) storage and packaging, and related costs.

Emphasising the contribution of open-space urban agriculture to urban food supply in Kumasi, Table 4.3 shows that the demand for vegetables (like lettuce or spring onions) as

well as fresh milk is nearly completely covered by inner-urban production. Food items like tomatoes, garden eggs and cassava as well as eggs and poultry meat are derived from the peri-urban area while staples, such as cocoyam, plantain, maize and rice come from rural areas or via import to the city markets in Kumasi. Another vital part of Kumasi's urban and peri-urban agriculture is poultry production, which is practiced by people from all social sectors. Vegetable farmers in and around Kumasi benefit from this, as it offers them access to cheap but high-quality organic fertilizers (Drechsel, 1996, Drechsel et al, 2000).

Table 4.3: Contribution of rural, peri-urban and market-oriented urban agriculture to urban food supply in Kumasi (Drechsel et al., 2006b).

Food item (examples)	Kumasi Metropolitan Area (%)	Peri-urban Kumasi (%)*	Rural and import (%) **
Cassava	10	40	50
Maize	< 5	5	90
Plantain	< 5	< 10	85
Yam	0	0	100
Cocoyam	< 2	< 10	90
Rice	0	< 5	95
Lettuce	90	10	0
Tomatoes	0	60	40
Garden eggs	0	60	40
Onions	0	0	100
Spring onions	90	<10	0
Poultry/eggs	15	80	< 5
Livestock	5	10	85
Fresh cow milk***	>95	< 5	0

* Using a 40 km radius from the city center.

** Mainly rice, onions and part of the livestock are imported. *** KNUST farm production.

Contributions to other urban development objectives. Urban farming can have substantial contributions to the city beyond the provision of livelihoods and food. These include among others contributions to flood control, land reclamation, land protection, resource recovery (from waste), urban greening and biodiversity etc. (see also table 11.1 in chapter 11). These contributions might be more important for some authorities than the food production per se but have not been quantified and assessed so far. An example is that urban open-space

farming protects unused land from squatters and uncontrolled waste dumping, thus saves expenditures on land maintenance and waste collection (Anku et al., 1998).

4.4 Externalities

When assessing the benefits of open space vegetable production to the society, there are also a number of possible negative externalities, which should not be ignored. A related checklist of environmental criteria was compiled by Anku et al. (1998). Examples are:

- the potential impact of polluted irrigation water on farmers' and consumers' health;
- the potential impact of pesticide use on farmers' and consumers' health
- soil nutrient depletion through frequent harvests and/or water pollution by farmers through the (over)use of manure, fertilizers and pesticides;
- stream siltation and eutrophication through erosion from cultivated slopes;
- increased urban malaria through the creation of mosquito breeding grounds

a) Health impact through pathogens in irrigation water.

Although there is ample evidence of irrigation related crop contamination with pathogens (see Chapter 9) an economic assessment of its health impact in Ghana is still missing. A major challenge in addressing this issue is that farmers and consumers might be exposed to a variety of similar or even higher pathogen-related risk factors (poor sanitation, lack of potable water, etc.), which make it difficult to value an individual risk factor, especially if the concerned persons do not perceive and record any particular problem (see Chapter 10). This corresponds with a related study in Ouagadougou, where perceived health records of 500-600 farmers and non-farmers were practically the same (Gerstl, 2001). However, the potential risk group is larger. As shown in chapter 5, every day more than 200,000 urban dwellers consume in Accra's streets lettuce produced with polluted water. As the amounts of the salad supplements are very small, the risk of infections due to pathogens is much higher for the consumer than any health risk due to pesticide accumulation (Amoah et al., 2005b).

b) Health impact through pesticide misuse.

A pilot assessment of the misuse of pesticides on farmers' health was attempted by KNUST-IWMI in the tomato producing area of Akumadan, Ghana (Gyiele, 2002b). The town of Bechem with dominantly traditional staple crop farming was used as control. Sources of data were farmers, hospitals/health posts, pharmacy/chemist shops and traditional medicine

practitioners (herbalists). Health records from Jan 2000 – May 2001 were analysed from about 10,000 persons per study area. In addition, about 170 farmers have been interviewed and 200 samples of tomato fruits analysed for pesticide residues.

In Akumadan, the annual pesticide usage is estimated at 500 tons of which 4% are organochloride compounds with residues found in water, soil and in human body fluids such as breast milk (Ntow, 2001). Despite many campaigns promoting *Integrated Pest Management* (IPM), only a minority of the farmers (16%) tested these including biological pesticides. However, these farmers often add chemical pesticides to these extracts for increased potency of the mixture (Okorley et al., 2002). Also "pesticide farmers" mix cocktails of two or more chemicals and often use their fingers and mouth to test the resulting potency (Danso et al., 2002b).

Restricted chemicals in use are, for example, Endosulfan (100% of the farmers interviewed), Carbofuran (82.5%) and Polytrine (81.7%) as well as Ridomil plus/Ridomil (Metalaxyl) (75.8%). Farmers also confirmed to administer Lindane in their spray mixture. Other pesticides used are Karate, Dithane, Unden, Thiodan and Actellic, which were applied singly or as a cocktail. Misuse and overuse are very common (Ntow, 2001; Gyiele, 2002b; Okorley et al., 2002; Ntow et al., 2006).

Table 4.4: Comparison of prevalent symptoms between Akumadan and Bechem farmers

	Akumadan (n=120)		Bechem (n=60)		
Symptoms	**Frequency**	**Percent**	**Frequency**	**Percent**	**Difference**
Headache	120	100	46	77	23
Burning sensation in eye	88	73	10	17	56
Weakness	84	70	28	47	23
Fever	114	95	35	58	37
Watering eye	87	73	6	10	63
Blurred vision	43	36	7	12	24
Dizziness	80	67	16	27	40
Nausea and vomiting	82	68	10	17	51
Cold/breathlessness/chest pain	21	18	6	10	8
Heart problems	12	10	6	10	0
Confusion	3	3	0	0	3

Source: Gyiele (2002b)

It was observed that because of lack of records, farmers could not give offhand information on the type of health reaction they have experienced in the past. However, common symptoms such as headache, nausea, vomiting, cold, weakness, chest pain etc. were significantly higher for Akumadan farmers compared to farmers in Bechem where pesticides are not used (see Table 4.4). The most common symptoms in Akumadan were headache 100% (77% for Bechem), fever 95%, burning sensation in the eye 73%, and general body weakness 70%. Comparing on percentage difference basis burning sensation in the eye, watering eye, nausea and vomiting for Akumadan are 56%, 63% and 51% higher than for Bechem.
Other symptoms – often discussed in public - are impotence in men and infertility in women (Mensah et al., 2001). However, only 17% of the farmers saw a corresponding relationship. Farmers associated bending and other strenuous activities with tomato production as likely causes of female infertility.
High rates of self-medication are common in the study areas and most farmers consult chemical sellers (60%) in mild to moderate cases while 15.8% rely on herbalists. Persistent ailments are usually believed to have a spiritual origin and are usually taken to the herbalist too. Herbalists are contacted in Akumadan 2-3 times as often as in Bechem. As such, hospital records only reflect severe cases and underestimate the full extent of cases. The same applies to routine health statistics submitted to and published by the Ministry of Health. To bridge this gap, additional assessments from herbalists were compared with farmers' testimony.
Death, as a result of pesticide poisoning, is rare. However, 16% of the farmers knew of people who had died from pesticide poisoning (occupational exposure), while 100% experienced convulsion and fainting after spraying or knew people who suffered these symptoms after pesticide application.

The methods used for the economic assessment at the farmers' level were:

- Cost of medical treatment;
- Opportunity cost of labor i.e. absence form farming activities due to pesticide poisoning; and
- Cost of drugs for treating minor illnesses.

Considering these three approaches, the annual costs summed up to US$ 125 per tomato farmer (Gyiele, 2002b). With farm sizes under tomato cultivation ranging mostly from 0.3 ha to 2.0 ha, it becomes obvious that smallholders in particular have to pay a significant share.
These costs were compared with the gains from pesticide use compared to a pesticide-free tomato production based on IPM principles and biological pesticides. Some initial

comparisons showed that the annual difference from using agro-chemicals vs. IPM could range between zero and more than US$ 2000 on hectare bases, depending on the kind and frequency of pest attacks. In other words, when there was no or little attack, both systems achieved the same yields and returns, while under severe attack the IPM farmers were apparently at higher risk of gaining less than those using pesticides. If confirmed, then this risk factor would not encourage the adoption of IPM, also under consideration of additional medical costs (assuming farmers perceive the relationship). Urban farmers confirmed this by stating that despite lower costs, IPM is simply too cumbersome and risky for them, compared to spraying "plant medicine".

A quantification of food-chain related pesticide uptake and cost assessment for the consumer was not possible in the frame of this study. But as shown above (see a)), the potential impact will be significantly smaller than through pathogen contamination.

c) Health impact through increased urban malaria.

In comparison with rural areas, West African cities are relatively **malaria**-free due to general water pollution. The malaria vector *Anopheles* needs very clean water for breeding. Adaptations of the vector to less clean water could however occur as reported from Accra by Chinery (1984). In a malaria study on a 15 ha urban farming site in Accra with 77 man-made shallow water reservoirs filled with either tap water or polluted water, either water pollution or natural predators and other known competitors (tadpoles) effectively controlled larval development (Miah, 2004). Nevertheless, studies conducted by IWMI in Kumasi and Accra (Afrane et al., 2004; Klinkenberg et al., 2005) showed that in some cases, significantly more mosquitoes were caught and/or more children were affected in communities around irrigated farming sites than non-farming sites. However, as urban agriculture is often practiced in urban lowlands or other greener areas, which might generally offer more resting and breeding grounds for mosquitoes than other city areas, an explicit link with local *farming* activities could not (yet) be established in these cases. A preliminary economic assessment of the additional health expenditure was based on a comparative study of urban areas with and without open-space farming considering treatment costs and working days lost. The analysis showed that on average, for all age groups in the city, sites with urban agriculture increase the risk of malaria attack by 0.22 attacks per person during a period of 6 months. In other words, every fourth to fifth person in the vicinity of irrigated urban agriculture will have malaria one time more than if he/she were living in a pure urban area. With a typical malaria treatment cost of US$ 1.0 per case, an urban household in the vicinity of urban agriculture will spend an

extra amount of 0.22 US$ x 6.6 household members for malaria treatment, i.e. 1.45 US$ over the observation period.

In addition, about 0.5 extra days will be lost per adult person in communities with urban agriculture than in those without. Under consideration of the average estimated household income, the number of working household members and the unemployment rate, the loss will cost the household another one dollar. In total, 2.45 US$ was attributed to each household over the 6-months period as extra malaria related expenditure in urban communities with open spaces used for irrigated urban agriculture (Gyiele, 2002b).

d) Environmental impacts.

In view of **water pollution** through fertilizers and pesticides, Gyiele (2002b) and Bower and Tengbeh (1995) concluded that the observed or likely contribution from urban smallholder farms is insignificant in view of the general pollution by the city. This could be different in rural areas where agriculture might be the only source of pollutants. In the tomato producing area of Akumadan, Ghana, with frequently reported pesticide overuse, pesticide residues in streams and sediments were however low, but monitoring of the build-up of residues was recommended (Ntow, 2001). A willingness-to-pay study (for safer drinking water instead of stream water) did not show much awareness for water pollution in this area (Gyiele, 2002b).

The risk of **stream siltation** will depend on the original vegetation cover along the streams and the cultivation practices of the farmers. It is possible that the year-round vegetable beds support soil conservation, increase infiltration and reduce run-off and erosion, thus contribute positively to flood control and urban drainage. On the other hand, studies in Harare, Zimbabwe, concluded that seasonal maize cultivation on slopes increased erosion. This led to a discussion of stream siltation and eutrophication through fertilizer use in urban farming (Bowyer-Bower et al., 1996; Mawoneke and King, 1999).

Irrigated vegetable production is one of the few forms of sedentary agriculture in West Africa where shifting cultivation is still the dominant land use system. However, with up to 10 lettuce harvests per year, soil nutrient mining is severe forcing farmers to provide continuous nutrient input. Especially on sandy soils, urban farmers enter into a vicious cycle of applying high rates of nutrients, which keep leaching out due to high rates of irrigation. As the irrigation water also contains nutrients and as the urban vicinity offers access to different waste resources, costs related to nutrient inputs can remain low. In and around Kumasi, for example, the poultry industry is very strong and farmers pay mostly for the transportation of

poultry manure, but not or very little for the manure itself (Drechsel *et al.* 2000). Thus, the related costs to vegetable farmers appear relatively lower than in rural areas where the most economic way to address soil nutrient depletion is still shifting cultivation (Table 4.5).

Table 4.5: Externalities due to soil nutrient leaching in and around Kumasi

System	Maize-Cassava intercrop	Year-round vegetable production
Cost assessment	The 2-year rental of a new plot is about US$10-50/ha depending - among others - on its proximity to the city, and accessibility.	Nutrient losses account for only US$10/ha/year if replaced with cheap poultry manure. Mineral fertiliser would increase the replacement costs tenfold.
Costs per year	US$5-25	US$10
Percentage of net income	Up to 10%	Up to 1 %

Source: Drechsel et al. (2005)

4.5 Conclusions

Urban farmers are able to cultivate all year round, which provides them with an earning capacity that is at least twice higher than that of their rural counterparts. This offers opportunities to move out of poverty. Open space urban farming also contributes substantially to the perishable food requirements of Ghanaian cities. This is partly because food flow from outside is constrained due to lack of cold transport and storage facilities available in less developed countries. Thus urban farming saves energy, transportation, storage and packaging costs. There are also a number of other possible benefits, such as flood control and land reclamation, which have not been quantified so far. On the other hand, there are different negative externalities, which can fluctuate widely with changing conditions, spatially and temporarily. Some of them (like water pollution) relate, however, more to the general challenges of urbanization and poor sanitation than to the farming practices per se.

Examples of externalities were given for farmers (pesticide misuse, nutrient depletion, wastewater exposure) and the society (malaria risks through irrigated urban farming). The data indicate that medical treatment related to the use of pesticides can be a significant cost factor for farmers. This, however, is not a typical problem of urban and peri-urban agriculture but of any farming system using pesticides. An assessment of the likely health impact of polluted irrigation water on farmers and consumers is still lacking. Based on the amounts of lettuce consumed, it can be assumed that the potential impact (and costs) for the society due to irrigation related pathogens is much higher than the possible impact of pesticide overuse.