

## 8. Irrigation practices

*This chapter describes the different irrigation methods and technologies used by farmers, understanding the factors for their choices and how they are being used. Seventy farmers were interviewed in Kumasi accompanied by focus group discussions in Accra and Tamale and field observations on all study sites. The chapter also describes the use of black water (faecal sludge) in Northern Ghana.*

### 8.1 Sources of irrigation water

As described in Chapter 6, sources and quality of irrigation water vary between piped water and raw wastewater. Most common is, however, the use of stream and drain water, highly polluted with domestic grey water. A brief overview of some key features in Accra, Kumasi and Tamale is presented here:

In **Accra**, the main source of irrigation water is urban drains<sup>1</sup>. The contents of these drains vary from raw wastewater as in Korle-Bu to storm water diluted wastewater as in Marine Drive, though this changes with seasons. In Dzorwulu, a polluted stream (Onyasia) is used in combination with pipe-borne water. Other than using a big drain that runs through Accra's La area, a few farmers there also use partially 'treated' wastewater' from the maturation pond of the stabilization pond treatment system belonging to the Burma military camp. Other farmers in La use piped water.

In **Kumasi**, polluted rivers and streams are the main sources of water for 70 % of the farmers. None of the farmers interviewed used (raw) effluent directly from the source or a sewage treatment plant. A very few cases ( $n < 5$ ) were recorded where farmers, because they have no choice, use wastewater from drains<sup>1</sup>. There is an extensive use of shallow dug wells on valley bottoms (27%), especially in the urban area. Of the 70 farmers interviewed, more than 75% said that they use the source of water that is accessible and reliable. Piped water is not only expensive but is unreliable and in any case inaccessible to most farmers.

In **Tamale**, with no perennial stream and a long dry season, water is scarce. Some farmers end up using drain water. In areas like Kamina, farmers use wastewater from a broken sewage treatment plant and others at "Waterworks" use water from a water supply dam, which has

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<sup>1</sup> These drains carry all sorts of storm- and wastewater including grey water and black water.

been abandoned due to water pollution. The agricultural use of faecal sludge in Tamale does not concern vegetables and targets its nutrient value, not the water (see chapter 8.5).

## 8.2 Irrigation methods and technologies used

Watering cans, buckets, motorized pumps with hosepipe, surface and sprinkler irrigation methods, as described below, are being used in the study areas.

### 8.2.1 Watering cans

This is the most common irrigation method used in all the study areas (Keraita et al., 2002b, 2003a). It is also the most precise one for fragile leafy vegetables. Farmers use watering cans to fetch and manually carry water from a water source, mostly shallow dug wells, streams or dugouts, to the fields, followed by watering of crops through the spout or shower head of the can (see Figure 8.1) making it an overhead irrigation method. In many cases, farmers carry two watering cans at a time. As men dominate irrigated urban farming, it is rare to see a woman with two watering cans. In peri-urban areas, where women are more common, they seem to prefer water fetching and application with buckets, often transported as head load. One watering can as used in Ghana has a capacity of 15 litres of water.



**Figure 8.1:** Lettuce irrigation with watering cans in Accra

Almost all farmers in the valley bottom of urban Kumasi use watering cans. Most of them have shallow dug wells on their farms and even for those who have to fetch water from streams, the distance is usually short (10-15 m). Previous studies (Keraita, 2002, Cornish et al., 2001) showed that farmers closer to water sources tend to over-irrigate in absolute crop water requirements. However, farmers are trying to keep their leafy vegetables fresh, thus irrigation is just wetting the soil surface and evaporation losses are significant.

### **8.2.2 Bucket method**

In this method, bowls and buckets are used to fetch water, usually from a stream/river or dugout. It is then manually carried to the fields where it is either applied directly or put in a drum to be applied later. This practice mostly involves women and children carrying buckets as 'head loads' and is commonly done in the peri-urban areas. Here male farmers can easily involve family members and take advantage of the traditional role of women and children in transporting water. Farms are comparatively further from the water source than the ones where watering cans are used, but normally are less than 50 m. The manner of watering (overhead or to the roots) is determined by crop height and type. Farmers using buckets and watering cans come in contact with water mainly by stepping in it while fetching, or water splashing on them while carrying and during watering. Crop contamination is very high due to the combination of crops with large surface area and overhead application (Figure 8.1).

### **8.2.3 Motorized pumps**

Motorized pumps are mostly seen in peri-urban areas, but also increasingly in Accra. A small motor pump is placed temporarily near a water source, usually the bank of a river or a big stream and water is pumped through rigid plastic pipes or semi-flexible pipes which are connected to a flexible hosepipe at the end. Farmers use the hose to apply water to their crops either overhead or near the roots on the surface. In other cases, pumps helped to reduce transport ways: water was pumped into a dugout from where water was fetched with cans.

In many cases where motorized pumps were used in Ghana, there were massive water losses with many pipes of inappropriate size or leaking. Farmers finally end up flooding fields along the pipelines and at the point of irrigation. More than one farmer is needed for the operation (e.g. one pumping, one irrigating). Irrigators are often fully wet as they try to fix the pump, pipes and direct the hose for irrigation. The fields are usually adjacent to the water sources and the pipes could be as long as 300 m. Due to the high velocity of water from the pipes,

watering can be done overhead even for tall crops like mature garden eggs. As the water pressure and the hose would damage leafy vegetables, usually only taller growing and stronger vegetables are irrigated in this way.

Though the total amount of water applied per season using this method was high (5 litres/second), the distribution and uniformity of application was poor. Pumps are hired from the 'wealthier' farmers for a constant fee per day (US\$3-5/day in 2000). In order to make maximum use of their money on the day of hire, farmers end up over-irrigating the areas most accessible to the feeder hose, leaving other areas of the field under-irrigated. In Dedesdua, a village in peri-urban Kumasi, to reduce costs, farmers on average irrigated once in three weeks (for a 120 day crop growth period) instead of once a week. This was equivalent to 5-10 hires over the 120-day period instead of 20 hires, which is a considerable saving for the farmer. They felt that this was sufficient for the crops but in reality such long cycles could affect crop productivity.

#### **8.2.4 Surface irrigation**

Some form of surface irrigation, mainly furrow is being practiced in La in Accra. La farming area is a comparatively wider open space with a topography that allows for furrow irrigation. The source of water is a drain that runs from the nearby military camp to its treatment plant. Farmers have constructed an open weir and diversion channel to irrigate their plots downstream by furrows (fruity vegetables), or they divert water into dugouts from where they can fetch with a watering can (leafy vegetables). During the dry season, farmers raise the water level in the drain with sand bags and divert the water in a main canal, which conveys the water to the plots. Furrow irrigation can reduce crop contamination since crops are grown on ridges, but exposure to farmers is as high as with water fetching from streams and drains.

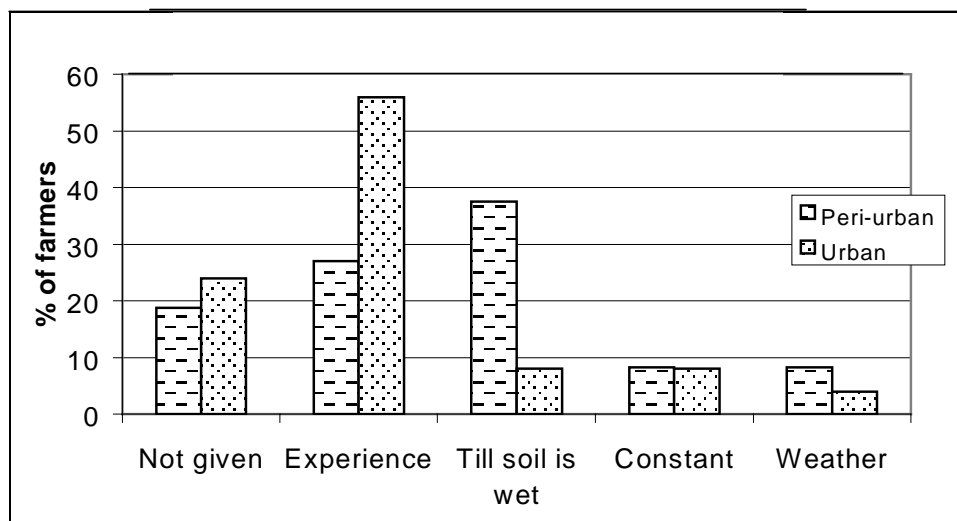
#### **8.2.5 Sprinkler irrigation**

This method was seen in a few sites (behind Georgia Hotel in urban Kumasi and Dzorwulu in urban Accra). In both cases, the sprinkler system is connected to a pipe borne water source. Low cost materials were used, like bamboos as sprinkler risers etc. These systems are the portable type and farmers in Dzorwulu combine them with the watering can method. The fields were reasonably large but the crops grown were the same as in the other areas. In this case, irrigation water has both on and off farm effects (aerosolised particles) on crops, farmers and the environment.

### 8.3 Water and land productivity

Leafy vegetables, which are the most commonly grown crops in irrigated urban agriculture, have higher and more regular crop water requirements compared to more traditional crops. According to Agodzo et al. (2003) irrigation water requirements of most vegetables grown in Ghana vary between 300 and 700 mm depending on the climatic conditions and crop species. As the extension service has limited training to support informal irrigation, farmers have learnt over time when and how much water to apply to their crops. When asked a question like “how do you know the amount of water to apply?” most urban farmers indicated that it was from ‘hands-on-experience’ mostly using soil and weather as indicators (see Figure 8.2). Generally, most farmers irrigate in the mornings and evenings, saying that at these times “*it is cooler so we can more easily carry the water-load*” which corresponds well with periods of low evapotranspiration rates, allowing other jobs during normal working hours (8am to 5pm).

Not all farmers can afford to buy irrigation equipment, like motorized or electrical pumps. However, neighborhood arrangements enable farmers to hire pumps on affordable terms. At Dedesua, in Kumasi, for instance, most farmers only pay for the fuel of a local motor pump. Payment can also be made on flexible terms such as paying after selling the crop or by providing labor for the pump owner. Some farming sites have farmers associations to exchange labor and irrigation equipment.



**Figure 8.2:** How farmers know the amount of water to apply

From field monitoring of water use, some farming sites in and around Kumasi showed a tendency towards over-irrigation in the urban areas by one-third of the irrigation water requirements and under-irrigation of the same magnitude in the peri-urban areas. Urban farms are much smaller (on average one-seventh) than peri-urban farms and farmers predominantly use watering cans for irrigation. Urban farmers achieve a more uniform spatial water distribution, though, because of the watering cans, and their irrigation intervals, which are regular. Peri-urban farmers use either buckets or motor pumps connected to water hoses. Peri-urban farmers have irregular irrigation intervals and poorer water distribution, especially those using hosepipes. As only a few peri-urban farmers own a pump, they wait for long periods before irrigating their farms 'queuing to hire a pump'. Subsequently it is quite common among these farmers to apply as much water as they can when the pump is available. The bucket method is laborious and depends on availability of women and children. This too contributes to irregular watering.

A good overview on tomato, garden egg, pepper, okra and onion production and yields in Ghana was provided by Nurah (1999), but few studies have been conducted on the productivity of vegetables common in Ghana's cities. Indicative studies on urban lettuce and cabbage production show typical production levels ranging between 20-35 tons/ha (lettuce, fresh weight) and about 40 tons/ha (cabbage) per crop. With e.g. 5 lettuce crops and 3 cabbage crops per year, the annual output is significant. Some variations across cities and seasons have been observed. For example, production levels in Kumasi are generally higher (10-20%) than in Accra, probably due to better soils except under excess rainfall, when levels start declining in Kumasi's inland valley bottomlands. Production during the wet season is higher in both cities than during the dry season. Preliminary calculations of water productivity under the *Challenge Program on Water & Food* project CP38 show a typical range of 6-9 kg/m<sup>3</sup> for lettuce grown in Kumasi, and about 8 kg/m<sup>3</sup> for tomatoes. However, the lettuce values could also be lower as calculations did not consider the period when seedlings are in the nursery bed (Keraita, unpubl.).

#### **8.4 Options and constraints to technology change**

Having to spend a significant share of time on irrigation (see Chapter 4) farmers desire less laborious and cheap irrigation methods that can reduce their workload. However the continued use of arduous methods of irrigation in urban agriculture, even when newer technologies are available, raises the question of the reason why these are not more widely used.

In Accra, farms are often found along streams and drains, and are at best tolerated by the authorities. The transport distance for the watering can is usually short enough to favor labor over capital input. Watering cans allow more flexibility, one-man-usage, and are less sensitive to bad water quality and solids. Moreover, they allow “soft” water application protecting young vegetables on their beds. All these are good reasons to avoid investment in pumps and hoses. In addition, there are differences in the related input markets (also for pumps and hoses) between Francophone Togo and Anglophone Ghana as well as in their practices and their promotion. EnterpriseWorks, for example, started promotion of treadle pumps in most Francophone countries of West Africa between 1995 and 1999, while corresponding activities in Ghana only started in 2002.

A comparison with neighboring Lomé, where farmers cultivate high value crops for export on poor quality beach sands using motorised pumps, shows that there is a combination of factors involved, which goes beyond the higher investment and maintenance costs of such technologies. Farmers in Lomé have access to larger plots, and the city authorities accept them (Figure 8.3). In many cases, tenure agreements exist. This security favors investments, for example, in tube wells and multiple storage ponds, i.e. transport saving technologies, which are necessary to maximize the profits from larger plots.



**Figure 8.3:** Watering can irrigation with well and storage reservoirs in Togo. Further reservoirs are visible in the background.

Thus it becomes again obvious that technology promotion has to consider a variety of local conditions, both biophysical and socio-economic. Shallow wells and watering cans may be the most appropriate technology, for example, in Kumasi's inland valleys. The demand for treadle or motor pumps might, however, rise on upland sites, and in Accra, especially where farmers can share one pump and the water sources are not too close. Treadle pumps might be tried where groundwater is available between 1 and 7 meters or the walking distance between field and water source is more than 50 m. If the pump is not mobile, the farm site needs facilities to secure the pump overnight as farmers might live far from their fields. Wherever there is better water quality than in drains, low-cost drip irrigation technologies like bucket-kits and drum-kits, could be tested. The authorities might support especially those changes, which could reduce the health risk associated with using polluted water, like storage (sedimentation) reservoirs.

### **8.5 Faecal sludge as a source of nutrients**

Farmers in Tamale and other northern parts of Ghana use faecal sludge in agriculture (Owusu-Bennoah and Visker, 1994; Cofie et al., 2005). Sludge is disposed of on farms during the dry season, allowed to decompose and mixed with the soil at the start of the rainy (farming) season. Generally, men are responsible for the acquisition (from septic trucks) and application of faecal sludge on farms. This is because men generally own the land due to the traditional set-up as there are no women fields.

Cofie et al. (2005) conducted interviews with 100 farmers using faecal sludge in Tamale and Bolgatanga (another urban center in northern Ghana). Half of the farmers were using tractors for land preparation, while the rest used hoes and bullocks. The average farming area is about one ha and though some farmers claimed to have been using faecal sludge for more than 25 years (Gumani community in Tamale), an average of about five years of use was recorded. Many farmers own land with less than 20% farming on family or hired land. About 63% received faecal sludge from the local assemblies' tankers, though they could wait for 1-3 weeks before delivery after making an unofficial request. Four out of five farmers said that they used faecal sludge to increase crop yields and improve fertility, however up to half of them experienced social constraints in its use.

#### **8.5.1 Methods for sludge application**

Methods of sludge application have been derived from the experience and understanding of the farmers. Over the years, farmers in Tamale have taken advantage of the climatic

conditions (see Chapter 2) to develop a safe method of faecal sludge application in their fields. The high temperatures lead to effective drying of the discharged sludge and allow the sludge to be handled easily while integrating it into the soil. Moreover the health risks associated with use of faecal sludge are reduced, as most microorganisms contained in the sludge die in high temperatures. By the start of the first seasonal rains (usually in April), most of the sludge is completely dry and ready for use. Most farmers grow cereals (maize and sorghum) on the fields fertilised with faecal sludge, i.e. **not** vegetables. Two main methods are used (Asare et al., 2003):

**i. Surface spreading:** this involves discharging faecal sludge at various points (accessible to the septic emptier) at random on farmers' plots. This is done during the dry season (October – December). By the end of the dry season (February-March), the faecal sludge applied becomes very dry. Farmers then gather and redistribute this material evenly on the field, before cultivation.

**ii. Pit method:** pits are dug on farms and rice and maize straw is placed at the bottom of the pit. Faecal sludge is then poured into the pit, which is large in size and can take several trips of the conveying truck. Layers of bran and straw are placed in between subsequent trips. The process is repeated until the pit is full. This is left to compost for months. Before the cropping season starts, the pit is emptied and the dry mixture of faecal sludge and straw is applied evenly on the field. The pit method is not as widely used as the surface spreading method because it requires quite high quantities of crop residues in combination with the faecal sludge.

### **8.5.2 Nutrients supplied through faecal sludge application**

From farmers' experience over the years, five trips of the suction truck of 4.5m<sup>3</sup> are used to fertilise one acre of land (0.4 ha). Farmers apply an average of 56 m<sup>3</sup>/ha. Through this practice, significant amounts of plant nutrients in terms of nitrogen (N), phosphorus (P) and potassium (K) are returned to the soil, and in addition the organic matter level is gradually built up. Based on the average concentration of nutrients in human excreta as reported by Drangert (1998), estimated amounts of N, P, K and carbon in the applied sludge are presented in Table 8.1. This estimate does not consider loss during sludge storage in septic tanks and the amount lost in the field beyond the reach of plants. Based on the current sludge application rate by farmers, about 550 hectares of land can be fertilised annually using the faecal sludge

that is generated in Tamale municipality alone at the current collection rates. In fact, because there is no sanitary sludge storage facility near Tamale, trucks dump the sludge in natural depressions around the city. The new landfill site with sludge sedimentation ponds will not benefit farmers and reduce a viable option for resource recovery towards a closed nutrient loop.

**Table 8.1:** Estimated amount of nutrients applied in faecal sludge by Tamale farmers

<i>Nutrient</i>	Total in human faeces (kg)	Total in m <sup>3</sup>	Amount applied (kg/ha)
Nitrogen (as N)	4.5	8.2	459
Phosphorus (as P)	0.6	1.1	61
Potassium (as K)	1.2	2.2	121
Carbon (as C)	11.7	21.3	1183

**Source:** Calculated after Drangert (1998) based on the nutrient concentration in human faeces per person-year. Density for faecal sludge is taken as 0.55 kg/m<sup>3</sup>

### 8.5.3 Farmers' views on constraints for faecal sludge use

Among the same set of farmers interviewed by Cofie et al. (2005), 74% expressed that they had no problem with using faecal sludge in agriculture. Those who noticed problems complained of foul smell and health issues like itching and foot rot, with very few saying that it attracted public mockery. The major constraints are highlighted below. The interviews were carried out before the new treatment ponds near Gbalahi were put in place:

- § Bad odor is a deterrent to its application on farms. Farmers are not allowed to use sludge in the city because of the odor.
- § Farmers who have fields near large concentration of houses are unable to use faecal sludge to improve soil fertility. Faecal sludge use is more in peri-urban areas.
- § Negative attitude of other people towards the use of human waste. For farmers on hired land, it is a common situation that landowners do not allow them to use sludge on their lands despite its positive effects on soil fertility. Some people also shun the consumption of crops cultivated with faecal sludge.
- § There is excessive weed infestation after the application of faecal sludge.
- § Land for farming is scarce around the Tamale Municipality.

§ Inability of the suction truck drivers to send faecal sludge to fields that are too distant from the city.

Like in Accra's faecal sludge treatment plant in Teshie-Nungua, Tamale's new sanitary landfill site at Gbalahi has the provision to use settled sludge to enrich composted solid waste. However, besides differences in quality, this would require that farmers organize and pay for compost transport. The current system of sludge dumping on farmers' fields appears more like a win-win situation (which could also enhance the lifetime of the stabilization ponds) as long as the environmental and health risks are under control. An alternative form of co-composting is under test in a Buobai near Kumasi. Due to the availability of cheap poultry manure, farmers' demand is, however, low (Cofie et al., 2006; Danso et al., 2006).

## 8.6 Conclusions and recommendations

Streams, drains and nearby shallow dug wells are the most common sources of irrigation water. Watering cans are predominantly used with good reasons, but make the task arduous. Motorised irrigation (pump and hose) is easier but is not recommended for every crop and sometimes results in poor distribution of water over space and time.

Much could be done to improve irrigation efficiency - not only where water is scarce, like in Tamale, but also where irrigation consumes too much labour and gives extra burden to women. However, there are no specialized extension services offered to irrigating farmers. Changing of irrigation methods and promoting new technologies however is complex and depends on both biophysical and socio-economic conditions, as comparison with the situation in Lomé has shown. In general, a lot still needs to be done at farm level to improve water and land productivity and also reduce the health risks associated with the use of (usually diluted) domestic (grey) wastewater. Such measures may include raising awareness levels of farmers, improving irrigation scheduling and efficiencies, and changing irrigation methods and technologies for safer ones (see Chapter 12).

Black water (sludge, nightsoil) is used not for irrigation purposes but for the nutrient content in peri-urban areas of Northern Ghana. Farmers either spread it on their fields in the dry season or stabilise it in pits before application. In principle, the sludge is dry and does not contain pathogens by the time the cereals are grown. Farmers did identify certain constraints to its use like odor, excessive growth of weeds and negative attitudes of others towards faecal sludge as a source of nutrients. However, the system appears as a suitable and low-cost option for safe nutrient recovery from urban waste.