Informal Irrigation in the Peri-Urban Zone of Nairobi, Kenya

Findings from an initial questionnaire survey

J M Hide J Kimani

Report OD/TN 98 March 2000









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Address and Registered Office: HR Wallingford Ltd. Howbery Park, Wallingford, OXON OX10 8BA Tel: +44 (0) 1491 835381 Fax: +44 (0) 1491 832233

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Prepared by	JON HOE
Approved by	(name) IRRIGATION ENGINEER
	(Title) P. LAWRONCE
	(name) SCETION MANNOTA
	(Title) Date $18/04/00$

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Executive Summary

Informal Irrigation in the Peri-Urban Zone of Nairobi, Kenya

Findings from an initial questionnaire survey

J M Hide & J Kimani

Report OD/TN 98 March 2000

This report is an output from KAR project R7132, "Improved Irrigation in Peri-Urban Areas", which aims to identify and quantify, the productivity, constraints and potential health hazards associated with informal peri-urban irrigation with the objective of identifying practical measures to sustain and enhance the productivity of these systems.

The research is based on field studies being carried out in and around Kumasi, Ghana, and Nairobi, Kenya. The survey reported in this Technical Note was carried out to provide quantitative information on the role of informal irrigation in the peri-urban zone of Nairobi, Kenya, examining its importance and contribution to family welfare, its technical characteristics, and the institutional, social, economic and technical constraints faced by practitioners. A parallel survey of practices in Kumasi is published as OD/TN 97. Earlier work, carried out in Kumasi, reviewed the potential impacts of surface water quality used for irrigation on human health. This was reported in OD/TN 95, Water Quality and Peri-Urban Irrigation.

These three reports together present the findings of the first phase of this KAR funded research, identifying the nature and extent of peri-urban irrigation in these two urban centres. A second phase of research is now under way to obtain more detailed, quantitative information on the range of different irrigation practices that this report, and the parallel Kumasi report, identifies. The results of these second stage studies will form part of the final output of this project, available in March 2001.

It is estimated that over 3,700 farmers carry out irrigation within a 20 km radius of Nairobi centre. These farmers cultivate over 2,000 ha in over 55 separate locations. It is likely that these figures underestimate the true number of periurban irrigators. The majority of this irrigation can be considered truly "periurban" in nature and is strongly influenced by Nairobi in terms of water source and quality, land tenure and marketing.

For 86% of the farmers, irrigation provides the main source of income for the household and for two-thirds it is the sole source of income. Nearly two-thirds of the farmers questioned were women. Average household income for the farmers interviewed was \$1,700 although nearly 60% have household incomes less than \$1,000. Incomes are lower in the more urban locations where land holdings tend to be smaller and land tenure is less secure. For example, average household income in Makadara district is just \$480. None of the farmers questioned currently make use of credit. Despite this, the farmers did not identify availability of credit as a major constraint to irrigated production. Lack of inputs such as seed



Executive Summary continued

and agro-chemicals did rank highly despite the proximity of suppliers in and around Nairobi.

Three-quarters of farmers rely on a single plot with an average size of 0.5 ha. Plots are owned by 31% of farmers and rented by 19% whilst 39% of the farmers questioned admitted to being squatters on government or Nairobi City Council land. It is assumed that the remaining 11% are also squatters but were reluctant to admit to the fact. Despite the high proportion of people having no right to the land they are farming, only one farmer stated that he had been harassed by anyone for cultivating where he did.

Over 50 different crops are grown ranging from local subsistence crops such as maize and kales, through to exotic vegetables such as celery and Chinese cabbage. The most widely grown crops are kales, tomatoes, cabbage and spinach. Average total gross income from crops is \$883 per farm. (Studies planned for the second stage of the project will look at detailed farm and crop budgets to derive gross margins). It is estimated that irrigated production within the 20 km radius produces crops worth over \$3.2 million per year. Gross incomes per ha range from \$65 for maize to over \$5,000 for celery and courgettes. Yields are generally low compared to what can be expected for irrigated production.

A wide variety of water sources are used. 56% use rivers and streams, 36% raw sewage water and 6% piped city council water. Availability of water and poor water quality is ranked as the primary constraint to irrigation. The most common method used to convey water to farmers' fields is by gravity channel. Pumps are used by 38% of farmers whilst 26% carry water manually to their plots. Water is applied using furrows and basins by 39% of farmers, watering cans and buckets by 31%, hoses by 25% and fixed sprinklers by 8%. Irrigation technology thus varies from low to high-tech. As would be expected, irrigation method is heavily influenced by water source.

Overall, water is ranked as the primary constraint. Availability of inputs, lost production through crop damage and theft and lack of labour are also identified as serious constraints. Despite the fact that a large proportion of farmers are squatters and none currently use credit, land and credit availability were not identified as major constraints.

The scoping survey and farmer questionnaire survey have identified the main features of peri-urban irrigation in Nairobi. However, further detailed information is required if appropriate interventions to improve irrigated production and thus household livelihoods are to be suggested. In the second phase of this research a smaller number of farms will be studied in detail to quantify farm and crop budgets and identify the technical, social and economic constraints and difficulties faced by the farmers.

Water quality is a prime concern with over a third of farmers using raw sewage water. It is therefore proposed that a suitable water quality study is carried out in conjunction with the above study.

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1. INTRODUCTION

There is considerable interest in the international community in developing sustainable resource management strategies for the urban and peri-urban environments of the cities of the developing world. This is evident in DFID's own Rural Livilihoods Research Department, which has a systems research programme dedicated to the peri-urban interface. (DFID, 1999). Further evidence is the submission to the Committee for Agriculture within the Food and Agriculture Organisation (FAO), at its 15th session in January 1999, of a proposal for FAO to establish an interdepartmental programme on the subject of urban and peri-urban agriculture (UPA). The proposal was accepted and a programme established. (FAO, 1999).

Another major initiative is the Cities Feeding People program of the Canadian based International Development Research Centre (IDRC). This program was established in 1993 and arose from earlier work on urban agriculture carried out in Latin America and the Caribbean. The program plays a key role in networking activities and commissions research in both technical and policy aspects of urban agriculture in Africa, Asia and Latin America. These three programmes serve to illustrate the interest currently focused on UPA but many other bilateral and multilateral agencies in addition to these have activities in the field of urban and peri-urban agriculture.

The rise of UPA up the development agenda has created a gap between the supply of and the demand for quantitative information on which technical and policy decisions can be based, with demand outstripping supply. This lack of a reliable information base applies to all aspects of UPA and must be addressed by programmes of research and information dissemination.

Both IDRC and FAO place emphasis on the importance of water as an input to urban and peri-urban agricultural production. IRDC cites the "critical importance of appropriate management of water resources in urban areas." (IDRC, 1998). FAO, (1999) in the submission to the Committee on Agriculture, highlighted the potential and risk associated with using wastewater for agricultural production. The submission makes the general statement that small-scale irrigation, using proper water quality management and monitoring and a crop selection programme, can avoid many of the problems associated with wastewater reuse. Despite these agencies highlighting the importance of irrigated agriculture within UPA there is little published or on-going research that focuses on this sector. This present work will hopefully contribute to filling this important knowledge gap.

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This report presents findings from the first stage of the work carried out in Nairobi. (A parallel report, OD/TN 97, describes similar studies for Kumasi). The work was carried out in association with SISDO (Smallholder Irrigation Scheme Development Organisation), a Kenyan NGO, and encompassed a literature review, scoping study and farmer questionnaire survey in order to provide information enabling understanding of the following types of issue:

- geographic distribution of irrigated cropping in and around Nairobi
- contribution of irrigated cropping to family welfare and cash income
- different irrigation practices that exist and their relative importance
- extent to which irrigated vegetable production has expanded in recent years
- importance of irrigated farming for men and women



• extent to which technical issues related to water supply and management are considered serious problems relative to other concerns over land tenure, labour, input supply, marketing etc

Subsequent studies at selected locations will provide more quantitative technical, social and economic data when types of irrigation practice and key issues have been identified.

2. URBAN AND PERI-URBAN ZONES AND THE STUDY AREA

Although no universally accepted definition of urban and peri-urban agriculture is available, it is generally accepted that a broad distinction can be made between urban and peri-urban production systems. Urban agriculture is usually very small-scale, non-commercial production carried out on vacant lots, in gardens or on roadside verges. It takes place in the urban zone and its primary purpose is food security rather than income generation. Peri-urban agriculture is found in the urban hinterland – a zone influenced by the presence of the urban centre but still rural or semi-rural in appearance. Production is carried out on a larger scale and is of a commercial nature with most produce being sold for cash income. Exceptions to these distinctions can be identified. For example, in Nairobi strategic central urban plots, readily seen and visited by car drivers, growing and selling ornamental plants are widespread and vacant housing lots in affluent residential areas growing vegetables for sale can be found in both Kumasi and Nairobi

It is not possible to delineate precise boundaries where the peri-urban zone begins and ends but it is the area adjacent to an urban centre, influenced by:

- pressure on land use conversion from rural to urban usage
- ready access to a large market
- ready access to services and physical inputs
- increasing problems of waste management and pollution from the urban centre

This study of urban and peri-urban irrigation practices has looked at irrigation occurring within a 20 km radius of the centre of Nairobi. Within this area pressure on land use and the associated problems of insecurity of tenure and rising land values are seen along with the other influences – market, service and input provision and resource pollution.

As part of the study, a local consultant (Log Associates) carried out a review of information and literature available in Nairobi relating to peri-urban irrigation. In total, 51 documents were identified from a wide variety of sources. Where no documents were identified at a particular source, interviews were conducted to establish whether there was any useful information to be gathered regarding this study. Appendix 4 contains details of the literature identified. The review identified access to land and the lack of capital as the major constraints to urban agriculture and irrigation. The use of sewage water and solid wastes in urban agriculture was identified as both a health and an environmental hazard. The role and contribution of institutions involved in urban agriculture is mentioned in some of the documents reviewed.

Generally, very few studies have been conducted on urban agriculture in Nairobi, and quantitative information is therefore limited. There is a lack of policies addressing urban agriculture and this poses difficulties for those wishing to practice agriculture in the city. The Nairobi City Council (NCC) is also hampered in trying to control clean water distribution and sewage disposal. Most urban farmers are restricted to farming in the wet seasons because they do not practice irrigation.

3. SURVEY METHOD

Information about irrigated agriculture within the peri-urban zone of Nairobi was obtained primarily through two surveys:

- 1 A scoping survey
- 2 A detailed farmer questionnaire

For both of these, the geographical limit was taken as a 20 km radius from the centre of Nairobi – a limit chosen after field reconnaissance and in consultation with staff from Smallholder Irrigation Scheme Development Organisation (SISDO) and the Ministry of Agriculture.

3.1 Scoping Study

An initial scoping study was carried out between June and July 1999. The objectives of the scoping study were to locate areas of significant irrigation activity and identify for each site:

- Water source
- Delivery method
- Areal extent
- Number of farmers (dis-agregated by gender)
- Land tenure
- Crops irrigated

The survey was conducted by SISDO with assistance from the Provincial Agriculture Office and the Divisional Agriculture and Extension Officers. Nairobi has seven administrative divisions of which six were considered, the central business district being excluded. Two additional divisions, Ngong in Rift Valley Province and Mavoko in Eastern Province, were included since they are on the fringe of the survey area and have significant irrigation activity.

During the scoping survey, 55 separate "clusters" were identified covering almost 500 ha (1,235 acres) with over 3,700 farmers (See Appendix 2). Figures 1 and 2 show the locations along with the number of farmers and area irrigated at each cluster. It is highly likely that these data under-estimate the true extent of peri-urban irrigation and that significant irrigation is practised within the selected zone that has not been identified, particularly in the more rural areas to the north of Nairobi.

3.2 Farmer Questionnaire Survey

In order to gain more detailed information about the irrigation activities identified, a random sample of 152 farmers were asked to participate in a farmer questionnaire. This sample represents approximately 3% of the farmers in 34 of the 55 sites identified in the scoping study. A further seven questionnaires were directed at "special" cases, i.e. farmers using boreholes, pumps and treadle pumps. Information from the Kamiti prison farm was also collected.

In each of the 34 areas selected, a target number of farmers was decided according to the random sample. Individual farmers within these areas were randomly selected from those present on their farms when the enumerators arrived at the sites. The farmer interviews covered personal and household information, household socio-economic factors, plot characteristics, water management, cropping pattern, agricultural inputs and yields, marketing and conception of constraints. The questionnaire is reproduced in Appendix 2.





Figure 1 Number of farmers per cluster



Figure 2 Cluster irrigated area (ha)

4. FINDINGS FROM FARMER QUESTIONNAIRE SURVEY

The following discussion is divided into the subject headings used in the questionnaire and presents the main findings. A complete set of results from the questionnaires is found in Appendix 3. References in *italics* in the following discussion refer to the table number in appendix 3 where the detailed results can be found.

4.1 Personal and Household Background

Nearly two-thirds, 63%, of the farmers interviewed were women (1.1). This is higher than was estimated during the scoping survey in which women made up 51% of the farmers. The supposition that more men find employment in Nairobi is not borne out however when the principal sources of household income are considered. Only 30 farmers (20%) said that small businesses ranked in the top three sources of household income whilst only eleven (7%) mentioned salaried or paid work ranked in the top three (2.2).

Farmers tend to be quite young -34% are between 20 and 29 whilst the average is age 36 (1.2). Women farmers are significantly younger than male. The average age of the female farmers is 33 compared with 40 for the men. Most farmers have not been practising irrigation for long, 49% have practised irrigation for less than five years and the average is seven years (1.12).

The majority of farmers, 71%, are Kikuyu, reflecting the fact that Nairobi is situated in Kikuyu land (1.3). About half the farmers, 51%, were born in Central Province, a quarter, 24%, in Eastern Province and 14% in Rift Valley. Only 4% of farmers were born in Nairobi itself (1.4). The average length of time farmers have lived in Nairobi is 18 years (1.11). It is clear that the vast majority of farmers practising irrigation in and around the city have moved towards the city from more rural locations.

The most common household size is four with two children (1.5, 1.6). For the whole sample, the average household size is 4.6 and the average number of children is 3.6.

Education levels of the farmers vary from 10% having received no formal schooling to 4% having had a university education. In between these extremes, the majority, 53%, received primary education, 28% secondary education and 6% having received tertiary or teacher training education (1.7). When education levels are cross-tabulated with sex there is a bias towards women having a higher education level than men. Only 1% of women have no schooling compared to 24% of men, whilst 5% of women have been to university compared to 2% of men. These figures suggest that education is a pre-condition for women to participate in irrigation but not so for men. 60% of all respondents claimed to be able to speak, read and write in English (1.8).

For 86% of the respondents farming is their main occupation. Teaching, civil service and business were the next common occupations with 2% each (1.9). Only one-third of the farmers claimed to have a second occupation after farming (1.10).

4.2 Human, Social and Economic Factors

Amongst the respondents irrigation is by far the most important contributor to household income ranking six times higher than small businesses, eleven times higher than livestock production and sixteen times higher than salaried or waged employment (2.2). Growing irrigated produce provides the main income for 86% of the farmers. Extra cash is the main objective for 9% and food production for 6% (2.1).



Farmers were asked to estimate their annual household income. Over half of the farmers replying to the question, 59%, reported incomes of less than \$1,000 per year (2.3). The distribution of incomes is shown in Figure 3. The average was \$1,700 with a minimum of \$43 and a maximum of $$15,920^{1}$.

Income data has been aggregated to district level and Figure 4 shows the geographical variation. The lowest household incomes are found in Makadara and Embakasi districts where the irrigation is characterised as more urban, often close to slum areas where landholdings are smaller. Higher household incomes are found in the more rural and upmarket districts of Langata and Westlands.

Because the accuracy of these estimates is likely to be quite low, farmers were also asked to describe the construction of their houses and their possessions in order to provide a further basis for comparison of relative incomes. Half of the farmers live in houses constructed of corrugated metal, 40% share a water standpipe and only 12% have mains electricity (2.5). Almost all households, 93%, have a radio, 23% have a TV, 17% a bicycle and 10% a car (2.4).

The use of credit is very low. Less than 5% used credit when they started irrigated production obtaining it from co-operatives, friends or NGOs (2.7, 2.8). However, no farmers reported using credit now (2.9). When asked to rank constraints to irrigated production, the score for credit was very low and ranked seven out of eight factors (7.2). The low use of credit appears to be because farmers choose not to use it rather than because they find it hard to obtain.



Figure 3 Estimated annual household income (US\$)

¹ Kenya shilling responses were converted to US\$ at the interbank rate of US\$1=KSh62.2 prevailing on 01/09/99



Figure 4 Average household income by district

Farmers were asked to identify the types of labour that were used for the following activities:

Activities

- land preparation
- planting/transplanting
- weeding
- applying manure
- applying agro-chemicals
- watering
- harvesting

Labour types

- respondent
- spouse
- other household
- exchange
- paid labour

Over two-thirds of the respondents worked on all activities, ranging from 72% for the application of manure to 90% for planting/transplanting and harvesting. In comparison, only about one in five of the farmers' spouses worked on any activity except for harvesting where 78% contributed their time. Other household members contributed on only 10% of farms. Paid labour was used on the majority of farms, most often for land preparation, planting and transplanting and weeding (2.10).

When labour is cross-tabulated with sex, there are no apparent trends or correlation between sex and the type of tasks carried out (2.10).

4.3 Landholding

Approximately half of the respondents farm land in more than one location and of this, one-third of the other land is irrigated (3.1, 3.2). Thus 72% of the farmers interviewed have only one irrigated plot from which the majority of their household income is derived.

Amongst the 71 farmers (45% of sample) who also cultivated rainfed land the *average* rainfed plot was 1.1 ha but nearly half of this group (46%), have less than 0.25 ha of rainfed land, i.e. there are a very few farmers with large rainfed holdings that skew the average (3.3).

On average, farmers irrigate a total of 0.6 ha, usually on a single plot. A quarter of the farmers report irrigating two plots and only 3% report irrigating three plots (3.4.1, 3.4.9, 3.4.10, 3.4.11).



Figure 5 Area of main irrigated plot (ha)

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Figure 6 Average irrigated area per farm by District

Looking at the main plot in isolation, the average size is 0.5 ha, although half the irrigated plots reported are smaller than 0.25 ha, i.e. the average is again elevated by a few large plots (See Figure 5) (3.4.1). The average area of the second and third plots reported is 0.3 ha (3.4.9, 3.4.10). Plot size data have been aggregated to district level and the geographical variation of average irrigated area irrigated is shown in Figure 6. The smallest land holdings are found in Makadara and Embakasi and the largest in Langata.

The plot is usually located away from the farmer's house, the average distance being 1.4 km. Eleven farmers, (7%), reported having to travel more than 5 km between their house and farm (3.4.2). The plots have been cultivated for an average of nearly eight years ranging from one to 55 years (3.4.3).

Irrigation is a year-round activity for the vast majority of farmers – over 90% report irrigating for twelve months per year (3.4.8). Flooding occurs every year on 21% of the farms and occasionally on 37% thus representing a potentially serious constraint for over half the farmers (3.4.7).

Land tenure is a complex issue. 39% of the respondents admitted to being squatters, this value corresponding roughly with the number of farmers stating that the land they cultivate is owned by the government or Nairobi City Council. Nearly one-third, (31%), claim to own the land. Cash tenants represent 15% and share tenants a further 4% (Figure 7). The tenancy of the remaining 11% is not clear, perhaps reflecting the reluctance of farmers to admit to squatting on government land (3.4.4, 3.4.5).

Ownership of land is more common in the more affluent districts of Westlands, Dagoretti and Langata (Figure 8). Squatters are more common in the poorer areas of Makadara and Embakasi where over three-quarters of the farmers have no official claim to the land they farm. Cash tenancy is most common in Ngong and Mavoko.

Where land is rented on a cash basis, annual rents per ha vary from less than US\$25 to over \$300. The average rent paid is \$75 per ha per year (3.4.6).



Figure 7 Land tenure of main irrigated plot





4.4 Water Management

Water, whether it be access to or quality, was ranked by the farmers as the biggest constraint to irrigated production (7.2). Over a third, (36%), reported that access to water limits their cultivated area, two-thirds of these because the source dries up, the other third because applying extra water requires too much effort. Yield reductions due to inadequate water are claimed by 48% of the respondents (4.5, 4.6, 4.10).

Farmers use water acquired from a wide variety of sources. Over half, (56%), use stream or river water with an additional 5% obtaining water from a natural pool or dug-out. A significant portion of the farmers, (36%), reported using sewage water. This water is obtained either directly from septic tanks (settlement ponds) or from the main sewers carrying sewage to the main Nairobi sewage works located to the east of the city. Only ten farmers, (6%), use water directly from the city council mains supply. Private boreholes and wells are used by five farmers, or 3% of those interviewed (4.1). Only a quarter of farmers judge the quality of the water used for irrigation to be good enough to drink. None of the farmers using sewage water would drink it (4.7). 15% of the farmers say that their crop choice is limited by low water quality (4.8).

Figure 9 shows the geographical distribution of water source. River and stream water is more commonly used in the outer-lying areas whilst sewage water is the principal water source in Makadara and Embakasi districts.

The most common method of conveying water to the fields is by gravity channel, this method being used on 42% of farms. Almost all farmers using sewage water use this method. Pumps are used by 38% of respondents, whilst just over a quarter, (26%), carry water to their fields manually. The ten farmers using city council water use pipes to carry water under pressure to their plots (4.3). The geographical distribution of conveyance method is shown in Figure 10.

Distances from water source to plot are generally small with 91% conveying water less than 50 m. The maximum distance reported was 2 km (4.2). However, it is likely that where farmers use gravity channels, they have stated the distance to the centre of their plots from the nearest channel rather than from the actual source. The actual distances will thus be considerably longer.

As would be expected, application method is strongly linked to conveyance method. Thus 39% of farmers apply water in furrows or basins corresponding to those farmers conveying water in gravity channels. Watering cans and buckets are used by 31%. Water is applied from hose pipes on a quarter of the plots and by fixed sprinkler on 8% (4.4). It is clear that the majority of farmers use low-technology methods. Analysis of the 60 farmers using pumps to convey water shows that the largest proportion, (43%), apply water directly from a hose whilst only 20% use a shower head or sprinkler to reduce the possible damage to crops (Figure 11). Figure 12 shows how application method varies geographically.

Treadle pumps are owned by seven farmers although 64% of respondents knew about them (4.12, 4.13). Of these, 44% had considered buying one (4.14). Of those who had not considered purchasing a treadle pump, the reasons given were that they were too expensive, (36%), that they are too tiring to use, (24%), that it is too time consuming, (7%), or that you can't pump enough water, (7%) (4.15).

Farmers were asked about the agricultural equipment that they owned or borrowed. Very nearly all owned a panga (machete) and jembe (hoe), the number of each owned being 1.8 and 3.6 respectively. 77 farmers, (49%), own a knapsack sprayer, this being the most common piece of equipment borrowed by farmers, (23%). A petrol or diesel pump is owned by (29%). Six farmers, (4%), own a tractor (4.12).



Figure 9 Irrigation water source by District





Figure 10 Water conveyance method by District



Figure 11 Application method for farmers using pumps



Figure 12 Water application method by District

4.5 Cropping Information

As mentioned earlier, irrigation is a year-round activity. The long and short rains occur in March – May and November - December respectively. During these periods, irrigation is supplemental only. A number of crops are grown continuously, for example, kales, spinach and tomatoes, whilst others are grown at specific times of the year. Table 1 shows the ten most popular crops when ranked by number of farms, area cultivated, gross income and gross income per ha (5.1.1, 5.1.2, 5.1.3).

It is seen that the four most widely grown crops are kales, tomatoes, cabbage and spinach. Together these crops are grown on 78 ha. The total calculated cropped area is 120 ha and taking the average farm size of 0.5 ha implies that the average cropping intensity is 150%. In reality the cropping intensity will be higher, perhaps as high as 200%, since information was only collected for the three or four most important crops grown by each farmer. The average number of crops grown by each farmer is 4.2 with a maximum of eight.

Table 1	Crop Rai	nkings						
Rank	Crops ranked by number of farms		Crops ranked by cultivated area		Crops ranked by gross income		Crops ranked by gross income per ha	
	Crop	No of	Crop	Area		Gross	Crop	Gross
		farms		(ha)	Crop	income		income
						(US\$)		per ha
								(US\$/ha)
1	Kales	81	Kales	30.1	Tomatoes	50,874	Celery	5,192
2	Tomatoes	45	Tomatoes	23.1	Kales	25,555	Courgettes	5,162
3	Spinach	38	Cabbage	12.5	Cabbage	13,579	Pepper	4,100
4	Maize	28	Spinach	12.1	Fr beans	13,524	Broccoli	2,856
5	Cabbage	21	Maize	11.6	Courgettes	7,743	Capsicum	2,389
6	Cowpeas	14	Fr. beans	8.9	Spinach	7,656	Tomatoes	2,201
7	Lettuce	8	Cowpeas	3.8	Cowpeas	2,965	Egg plant	2,080
8	Beans	7	Beans	3.4	Broccoli	2,399	Cauliflower	2,070
9	Fr beans	7	Lettuce	2.9	Egg plant	2,288	Fr beans	1,520
10	Onions	7	Courgettes	1.5	Lettuce	2,251	Sugarcane	1,280
11	Ar roots	5	Onions	1.4	Cauliflower	1,889	Cabbage	1,079
12	Amaranth	4	Egg plant	1.1	Pepper	1,312	Amaranth	1,076
13	Sugarcane	4	Amaranth	1.1	Celery	1,246	Ar roots	900
14	Egg plant	3	Arr roots	0.9	Amaranth	1,178	Kales	849
15	Cauliflower	3	Cauliflower	0.9	Capsicum	1,003	Cowpeas	776
					Maize	775	Spinach	632
							Maize	65

Note: Data refers to four most important crops on each farm Most commonly grown crops shown in **bold**

In order to see whether there is any geographical pattern in crop choice, crops have been divided into three categories:

- Subsistence crops, e.g. arrow roots, maize, kales, cassava
- Local market vegetables, e.g. beans, tomatoes, egg plant, cabbage
- Exotic vegetables, e.g. celery, Chinese cabbage, cucumber, lettuce

Figure 13 shows the geographical distribution of these crop types. The highest proportion of local vegetables and subsistence crops are grown in Mavoko district. It is notable that significant exotic vegetable production occurs in Makadara where farmers have smaller plots with no land rights, use sewage water and are in the poorer areas of Nairobi. Proximity to markets may encourage production of these exotic crops in these areas but a point of concern is that many of these exotic crops are eaten raw, unlike the subsistence and local market crops that are generally cooked.



Figure 13 Crop type by District



The total gross income (no production costs are deducted) calculated for these crops is \$139,553 or an average of \$883 per farm. If this figure is applied to all of the farms identified in the scoping study, peri-urban irrigation around Nairobi generates a cash flow of over \$3.2 million.

Gross incomes per ha range from \$65 for maize to over \$5,000 for celery and courgettes (5.1.3). The trend is for the more exotic, speciality vegetables to give higher gross incomes than the local vegetables and subsistence crops. However, it is likely that production costs will be higher for the exotic vegetables reducing the gross margin associated with these crops. The requirement for improved husbandry practices will also reduce the attractiveness of these crops to many farmers. In fact, only three farmers grow celery and two, courgettes. The four most common crops – kales, tomatoes, cabbage and spinach – give average gross returns per ha of US\$849, \$2201, \$1079 and \$632 respectively.

Crop yields were calculated on the basis of reported harvest and area grown. Initial calculations gave yields for some farms that were unrealistically high. In order to give realistic averages, extreme yields were discounted from the analysis. Table 2 gives calculated yields for the ten most common crops along with expected yields (5.1.4). Yields achieved by the farmers interviewed tend to be at the lower end of the expected range.

Сгор	Calculated yield (t/ha)	Expected yield (t/ha)
Kales	7.23	3 – 15
Tomatoes	11.56	10 - 30
Cabbage	4.5	10 - 30
Spinach	7.38	4 - 20
Maize	2.70	5 - 10
French beans	3.93	2 - 5
Cowpeas	3.17	3 – 5
Beans	0.85	1 - 2
Lettuce	5.3	5 - 10
Courgettes	10.67	n / a

Table 2Calculated and expected yields

Market prices stated by the farmers agree closely with the figures published by the Ministry of Agriculture, supporting the accuracy of the calculations (5.1.5).

The farmers were asked to indicate what inputs – commercial seed, herbicide, insecticide, fungicide, fertiliser and farmyard manure – they used with which crops (5.2). Commercial seed was used by nearly all farmers for the majority of crops, the exceptions being lower value crops such as arrowroots, bananas, sugar cane and sweet potatoes. Herbicide use is rare other than on capsicum, celery, peas and potatoes. Insecticide, fungicide and chemical fertiliser use followed similar patterns and was used more commonly on market vegetables. Farmyard manure was used on nearly all crops.

Formal extension advice was received by less than a third of the farmers, 30% (5.3). This fact, in conjunction with limited water supply and probable low levels of fertilizer application, possibly explain the poor yields achieved.

4.6 Marketing

All respondents said that they market produce as individuals. No one markets as a member of a cooperative or informal group (6.2).

The most common marketing options are individuals buying produce directly from the farmer's field, (70% of farmers), and middlemen buying from the field, (65%). Three-quarters of the farmers also



take the produce to market themselves. Local markets are the most important for the farmers questioned, followed by other markets in Nairobi. No farmers thought that their produce was exported to other African countries or to overseas markets (6.1).

4.7 Farmers' Conception of Constraints

When asked whether they planned to extend their irrigation activities, 15%, said they intended to do so within a year, 10% within two years and 60% sometime. The remainder, 16%, do not plan extending (7.1).

In order to understand which factors constrain the farmers most, each farmer was asked to identify and rank constraints to irrigated production (Figure 14). The ranking scores should be interpreted on the basis that a score of 1.00 means all farmers ranked that constraint as the prime constraint.



Figure 14 Farmers' conception of constraints

For the irrigators as a whole, obtaining an adequate supply of water of an acceptable quality is ranked as the primary constraint. Obtaining other inputs, such as seed and agro-chemicals, is also a serious constraint along with crop damage, these two constraints being closely linked. Since the farms included in this study are close to the urban centre, theft of both crops and equipment is a big problem. Over two-thirds of the farmers, (69%), reported that crops are stolen from their plots and of these, half felt that it is a major problem (5.4, 5.5). Just over a quarter, (28%), had had equipment stolen from the field, 25% of these stating that it was a major problem (5.8, 5.9). Availability of labour is given a similar ranking.

Given that a large proportion of farmers are squatting on government land, it is perhaps surprising that availability of land is not perceived as a major constraint. Only one farmer reported being harassed for cultivating on government land (5.6) suggesting that the authorities operate a laissez-faire policy towards peri-urban farmers. Credit and marketing are ranked last.

Figure 15 shows how the constraints are ranked according to land tenure. Landowners follow the pattern described above but for tenants, supply of inputs is seen as the biggest constraint. Tenant farmers also rank marketing as a greater constraint than landowners. The availability of land is not ranked as a major constraint even amongst squatter farmers. For this group, theft and water are the highest-ranking constraints. Data have been similarly analysed according to water source (Figure 16). From this it is worth noting that for farmers using sewage water, theft becomes the greatest constraint, perhaps reflecting their more urban location, with water as the second highest constraint. For farmers using city council water, it is the price paid for the water that impacts greatly on their farming system.



Figure 15 Farmers' constraints for differing land tenure



Figure 16 Farmers' constraints for differing water source

5. SUMMARY OF PRINCIPAL FINDINGS

5.1 Extent and Role of Informal Irrigation

- 5.1.1 From information gathered in the scoping survey, it is estimated that over 3,700 farmers carry out irrigation within a 20km radius of Nairobi centre. These farmers cultivate over 2,000 ha in over 55 separate locations. It is likely that these figures underestimate the true number of peri-urban irrigators.
- 5.1.2 The majority of this irrigation can be considered truly "peri-urban" in nature in that it is strongly influenced by Nairobi in terms of water source, land tenure and marketing.
- 5.1.3 For 86% of the respondents, irrigation provides the main source of income for the household and for two-thirds it is the sole source of income. Nearly two-thirds of the farmers questioned were women.
- 5.1.4 Average household income for the farmers interviewed was US\$1,700 although nearly 60% have household incomes less than \$1,000. Incomes are lower in the more urban locations where land holdings tend to be smaller and land tenure is less secure. For example, average household income in Makadara district is just \$480.
- 5.1.5 None of the farmers questioned currently make use of credit. Despite this, the farmers did not identify availability of credit as a major constraint to irrigated production. Lack of inputs such as seed and agro-chemicals did rank highly despite the proximity of suppliers in and around Nairobi.
- 5.1.6 Three-quarters of farmers rely on a single plot that is on average 0.5 ha in size. Plots are owned by 31% of farmers and rented by 19% whilst 39% of the farmers questioned admitted to being squatters on government or Nairobi City Council land. It is assumed that the remaining 11% are also squatters but were reluctant to admit to the fact. Despite the high proportion of people having no right to the land, only one farmer stated that he had been harassed by anyone for farming where he did.
- 5.1.7 Over 50 different crops are grown, ranging from local subsistence crops such as maize and kales, through to exotic vegetables such as celery and Chinese cabbage. The most widely grown crops are kales, tomatoes, cabbage and spinach. Average total gross income from crops is \$883 per farm. (Detailed studies planned for the second stage of the project will look at detailed farm and crop budgets in order to derive gross margins). It is estimated that irrigated production within the 20 km radius produces crops is worth over \$3.2 million per year.
- 5.1.8 Gross incomes per ha range from \$65 for maize to over \$5,000 for celery and courgettes. Yields are generally low compared to national averages for irrigated production.
- 5.1.9 Irrigation is a relatively new activity for most farmers; 49% have been irrigating for less than five years.

5.2 Types of Irrigation Practice

- 5.2.1 A wide variety of water sources are used. 56% use rivers and streams, 36% raw sewage water and 6% piped city council water. Availability of water and poor water quality is ranked as the primary constraint to irrigation.
- 5.2.2 The most common method used to convey water to farmers' fields is by gravity channel. Pumps are used by 38% of farmers whilst 26% carry water manually to their plots.



5.2.3 Water is applied using furrows and basins by 39% of farmers, watering cans and buckets by 31%, hoses by 25% and fixed sprinklers by 8%. Irrigation technology thus varies from low to high-tech. As would be expected, irrigation methodology is heavily influenced by water source.

5.3 Constraints to Irrigated Production

- 5.3.1 Overall, water is ranked as the primary constraint. Availability of inputs, lost production through crop damage and theft and lack of labour are also identified as serious constraints. Despite the fact that a large proportion of farmers are squatters and none currently use credit, land and availability of credit were not identified as major constraints.
- 5.3.2 For farmers in the urban areas of Nairobi who tend to be those squatting on government land and using sewage water theft of crops and equipment is identified as the biggest problem.

5.4 Recommendations for Further Study

- 5.4.1 The scoping survey and farmer questionnaire survey have identified the main features of periurban irrigation in Nairobi. However, further detailed information is required if appropriate interventions to improve irrigated production and thus household livelihoods are to be suggested. In particular, it is proposed that a smaller number of farms are studied in detail in order that farm and crop budgets can be determined and the constraints and difficulties faced by the farmers can be properly understood.
- 5.4.2 Water quality is a prime concern with over a third of farmers using raw sewage water. It is therefore proposed that a suitable water quality study is carried out in conjunction with the above.

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Appendices





Appendix 1

Results of scoping survey



Appendix 1 Results of Scoping Survey

PERI-URBAN IRRIGATION STUDY HR WALLINGFORD, UK / SISDO, KENYA

SCOPING SURVEY - NAIROBI SUMMARY RESULTS

	Location	V	Vater s	ource			Conveya	ance		Farm	details			Land te	nure																Cro	ps															
Division	Location	River Borehole/well	City Council Sewage	Dam	Pond Seepage	Bucket Pump	Furrow	Hose pipe Overhead	کے Numb of farme	er rs Female	Male	Area (acres)	Freehold Leasehold	Government land	Squatter City Council land	State land	Kales Spinach	Tomatoes	Cabbage Arrow root	Maize	Bananas Capsicum	Onions	Lettuce Napier grass	Sugar cane Coriander	Carrots	Egg plant	Sweet potatoes Fruit trees	Leeks	Beans	Cauliflower Chilli pepper	Cow peas	Spring onions	Cassava	Celery Cucumber	Broccoli	Potatoes Chinese cabbage	Dill	Flowers French beans	Lucern	Nightshade Peas	Pigeon peas	Pumpkins Strawberries	Courgettes	Cucumber	Star grass Water melon	White creole	No of crops
Total Average		29 8	7 6	6 2	4 0	24 1	6 19 [·]	16 14	1 36	500 519	6 49%	1154 0.32	27	9 7	3 1	1 1	34 3	2 32	20 22	2 18	17 1	4 15	12 12	12 8	8 9	10	99	9	6 5	5	6 6	5	5 5	5 4	4 3	3 1	1 3	2 2	2 2	3 2	3	2 :	2 1	0	0 0	19	9.6
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Farmer questionnaire



Appendix 2 Farmer questionnaire

IMPROVED IRRIGATION IN THE PERI-URBAN ZONE OF NAIROBI HR WALLINGFORD LTD, UK & SISDO, KENYA

SCOPING STUDY INDIVIDUAL FARMER QUESTIONAIRRE

Name of respondent:
Name of enumerator:
Date of interview:
Field checker:

Quality Assurance

Please initial

	Data	Spreadshee	Validation
	checking	t entry	
Section 1			
Section 2			
Section 3			
Section 4			
Section 5			
Section 6			
Section 7			
Section 8			



Section 1: General Information

1.1	Farmer's sex:							
1.2	Farmer's age:							
1.3	Farmer's ethnicity:							
1.4	Region of origin:							
1.5	How many people live in the farmer's household:							
1.6	How many children does the farmer have:							
1.7	What is the education level of the farmer:							
	1 primary, 2 secondary, 3 teacher training/post secondary, 4 university/advanced diploma 5 never been to school							
1.8	English comprehension:							
	1 speak, 2 read and write, 3 speak, read and write, 4 none							
1.9	Main occupation of farmer:							
	1 farmer2 teacher3 trader4 driver5 mason6 carpenter7 cobbler8 mechanic9 tailor/seamstress10 cook11 hawker12 health worker13 construction labourer14 farm labourer15 police force16 civil servant17 business man/woman18 craftsman19 none20 other (pleasespecify)							
1.10	Second occupation of farmer:							
	Use codes as above							
1.11	How long has the farmer lived in Nairobi (years):							
1.12	How long has the farmer practised irrigation(years):							



Section 2: Human, Social and Economic Factors

2.1 Which of the following statements best describes the main objective of the farmer in growing irrigated produce?

Circle one option

- 1 To provide the main cash income for the household
- 2 To provide extra cash for the household
- 3 To provide income for future investment in another or new business
- 4 To provide food for the household
- 5 Other (please specify): _____
- 2.2 Do the household members do any of the following?

Please rank them in importance for their contribution to household income. Rank the most important activity 1. Household member: 1 self, 2 spouse, 3 child, 4 other

Activity	Rank	Household member
Salaried or waged work		
Occasional labour/paid on a daily basis		
Small business, eg hairdresser, jua kali		
Growing rain-fed crops		
Livestock rearing		
Poultry		
Irrigated crops		
Providing local transport, eg taxi, van		
Hawker		
Remittances from other family members		
Other (please specify)		

- 2.3 What is the estimated annual household income (KSh): _____
- 2.4 Do members of the household own any of the following items: *Please circle any that apply*

1 Car/pick-up/van	2 Tractor	3 Motorbike
4 Bicycle	5 Television	6 Radio
7 Fridge		

Concrete/masonry con Adobe construction Mains electricity Shared water standpip Iow many rooms in the Did you use credit when YES NO	e house? you first started	2 Corrugate 4 Mud cons 6 Private m 8 Private w 1 irrigated ag	ed metal construction struction ains water ell griculture?	'n						
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How many rooms in the Did you use credit wher YES NO f yes, where did you ob	house?	l irrigated ag	griculture?							
Did you use credit when YES NO f yes, where did you ob	n you first started	l irrigated ag	griculture?							
YES NO f yes, where did you ob				Did you use credit when you first started irrigated agriculture?						
NO f yes, where did you ob										
f yes, where did you ob										
ieuse circie uny inui up	otain the credit?									
Bank	2 Money lender	3 N	GO	4 Middleman						
Friend	6 Relative	7 C	o-operative group							
Other (please specify)	:									
Do you use credit now?										
1 YES										
NO										
f yes, where did you ob Please circle any that ap	otain the credit? oply									
Bank	2 Money lender	3 N	GO	4 Middleman						
Friend	6 Relative	7 C	o-operative group							
Other (please specify)	:									
What problems have be	en associated wi	th obtaining	credit:							
	Friend Other (please specify) Oo you use credit now? YES NO f yes, where did you ob <i>lease circle any that ap</i> Bank Friend Other (please specify) What problems have bee	Friend 6 Relative Other (please specify):	Friend 6 Relative 7 C Other (please specify):	Friend 6 Relative 7 Co-operative group Other (please specify):						



2.12 What type of labour do you use for the following activities?

Please indicate all types used

Activity	Self	Spouse	Other HH ¹	Exch- ange	Paid	Unpaid	Other
Land preparation							
Planting/transplanting							
Weeding							
Applying manure							
Applying agro- chemicals							
Watering							
Harvesting							

Note: ¹ Other household members



Section 3: Land Information

3.1 Does your household farm irrigated or rainfed land at more than one location?

1 YES

 $2 \, \text{NO}$

3.2 If yes, is the other land irrigated?

1 YES

2 NO

- 3.3 How much rainfed land do you farm in total (acres): _____
- 3.4 Provide the following information for each **irrigated** plot farmed by the farmer:

Question	Plot 1	Plot 2	Plot 3
Approximate size of plot (acres)			
Distance of plot from house (km)			
How many years have you farmed this plot?			
Who owns the plot?			
1 Household, 2 Nairobi City Council, 3 Government, 4 Private, 5 Other			
Current tenure			
1 Owned, 2 Shared tenant, 3 Cash tenant			
4 Temporary holding (squatter), 5 Other (please specify)			
Amount paid in rent, if any (KSh)			
Term if cash rental			
1 Monthly, 2 Quarterly, 3 Yearly			
Does the land flood?			
1 Never, 2 Occasionally, 3 Every year			
How many months of the year do you irrigate crops?			



Section 4: Water Management

4.1	Irrigation water source:							
	1 City Council Water	2 Stream/river		3 Shallow dug-out				
	4 Well or borehole	5 Natural pool	pond	6 Sewage water				
	7 Gutter	8 Other (please	e specify):					
4.2	Approximate distance from centre of plot to the main water source (m):							
4.3	.3 Conveyance method from source to field: More than one response may be circled							
	1 Manual (bucket/watering can)	2 Pumped					
	3 Manual with occasional pump	o hire	4 Council wate	r and hoses				
	5 Gravity channel		6 Seepage flow					
	7 Other (please specify):							
4.4	Field application method: More than one response may be	e circled						
	1 Watering can/bucket filled at the source							
	2 Watering can/bucket filled from field-side container							
	3 Furrow or basin							
	4 Hose pipe without sprinkler							
	5 Hose pipe and shower head							
	6 Hose and fixed sprinkler							
	7 Other (please specify):							
4.5	Does your access to water limit	the area that yo	u cultivate in any	part of the year:				
	1 YES, because the source may	dry up						
	2 YES, because it requires too much effort to carry more water							
	3 NO							

4.6 Do you think your yield is reduced because you cannot apply enough water to your crop?

1 YES

2 NO

4.7 Would you drink the water you use for irrigation?

1 YES

2 NO

4.8 Does water quality affect your choice of irrigated crops?

1 YES

2 NO

4.9 How much do you pay for water?

Téorre	A	Tarre
Item	Amount	Term
		1 per barrel, 2 per irrigation
		3 per day, 4 per month
		5 per cubic metre,
		6 other (please specify)
PUMP		
hire charge		
fuel		
labour		
CARRIED		
labour		
COUNCIL WATER		
water bill		
labour		

4.10 Are you able to apply as much water as you would like to your crops?

1 YES 2 NO

- 4.11 If no, what is it that limits the amount you apply?
 - 1 Cost of labour to carry or apply water 2 Cost of water bill
 - 3 Cost of pump hire or operation 4 The work is too hard
 - 5 Not enough water available at source 6 Water quality and fear of crop damage
 - 7 Other (please specify): _____



Equipment	How many owned	Borrowed/hired
Panga		
Jembe		
Shovel		
Watering can		
Water hose		
Sprinklers		
Drippers		
Pump (petrol/diesel)		
Pump (hand/treadle)		
Knap-sack sprayer		
Bucket		
PVC pipe		
Borehole		
Water barrel		
Tractor		
Other (please specify):		

4.12 What equipment do you own and use?

- 4.13 Do you know what treadle pumps are?
 - 1 YES

2 NO

- 4.14 If yes, have you considered buying one?
 - 1 YES

2 NO

4.15 If no, why not?

1 Too expensive

2 Too tiring

- 3 Too time consuming
- 4 Can't pump enough water
- 5 Other (please specify): _____



Section 5 Cropping Information

5.1 Record the annual cropping pattern:

Plot 1 identification: _____

Crop	ſ	F	1 A	Μ	ſ	J A	S	0	Ζ	D	Area (steps)	Yield	Unit	Price per unit	Percentage sold
Example: Brinjal			Irrigat	tion in	terval	5	-		-		20 x 10	001	sack	11,000	90%0



OD/TN 98 26/05/00

5.2 Do you use any of the following for your crops:

Crop:		
Commercial seed		
Herbicide		
Insecticide		
Fungicide		
Chemical fertiliser		
Farmyard manure		

5.3 Do you receive formal extension advice?

1 YES

2 NO

5.4 Are any of your crops stolen from the field?

1 YES

 $2 \, \text{NO}$

- 5.5 If yes, is this a major problem?
 - 1 YES
 - 2 NO
- 5.6 Do you experience any harassment because you are growing crops in this location?
 - 1 YES

2 NO

- 5.7 If yes, who from? ______
- 5.8 Has any of your equipment been stolen from the field?

1 YES

2 NO

5.9 If yes, is this a major problem?

1 YES

2 NO



Section 6: Marketing

6.1	How do yo <i>Circle as m</i>	u sell your produce? any as apply			
	1 Take proo	duce to a market. Where	?	_	
	2 Individua	ls buy from the field. W	here do they come from?		
	3 Traders (middlemen) buy from the	e field. Where does the pr	oduce go?	
	4 Contract	with an institution. Whe	re?		
	5 Other (pl	ease specify):			
	Codes:	1 Local market 4 Other Kenya	2 Nairobi 5 Export to Africa	3 Mombassa 6 Other export	
6.2	Do you ma	rket your produce as:			
	1 An indivi	dual			
	2 A membe	er of an informal group			
	3 A membe	er of a co-operative			

Section 7: Farmer's Conception of Constraints

- 7.1 Are you planning to expand your irrigation activity?
 - 1 This year 2 Next year
 - 3 Sometime 4 Never
- 7.2 Rank the three most important factors which most inhibits your irrigated production at present?

	RANK
Water	
Land	
Labour	
Inputs	
Credit	
Market-ing	
Crop damage	
Theft	



Section 8: Enumerator's conception of farm appearance

NOTE: Not to be addressed to the farmer

- 8.1 Place the farm in one of the following categories based on your assessment of land preparation, land formation, crop layout, weed control, crop condition, etc
 - 1 Good
 - 2 Average
 - 3 Poor



Appendix 3

Results from farmer questionnaire survey



Appendix 3 Results from farmer questionnaire survey

PERI-URBAN IRRIGATION STUDY – NAIROBI, KENYA RESULTS OF FARMER QUESTIONNAIRE

SECTION 1: GENERAL INFORMATION

Percent
37.3
62.7
100.0

1.2 Farmer's age

Descriptives		
Mean	35.8	(40.3 men, 33.2 women)
Standard deviation	13.9	
Minimum	2	
Maximum	85	
Frequencies	Number	Percent
age<20	8	5.1
20-24	26	16.5
25-29	27	17.1
30-34	20	12.7
35-39	22	13.9
40-44	16	10.1
45-49	15	9.5
50-54	10	6.3
55-59	3	1.9
age∆60	11	7.0
TOTAL	158	100.0

1.3 Farmer's ethnicity		
Frequencies	Number	Percent
Kikuyu	112	70.9
Kamba	29	18.4
Luhya	6	3.8
Luo	3	1.0
Kisii	1	0.6
Kalenjin	1	0.6
Meru	5	3.2
Maasai	1	0.6
TOTAL	158	100.0

1.4 Region of origin

Frequencies	Number	Percent
Nairobi	7	4.4
Central	81	51.3
Eastern	38	24.1
Rift Valley	22	13.9
Nyanza	3	1.9
Western	6	3.8
Coast	1	0.6
TOTAL	158	100.0

Descriptives		
Mean	4.6	
Mode	4	
Standard deviation	2.6	
Minimum	1	
Maximum	17	
Frequencies	Number	Percent
1-2	31	20.5
3-4	48	31.8
5-6	45	29.8
7-8	19	12.6
9-10	5	3.3
11-12	1	0.7
13-14	1	0.7
number>=15	1	0.7
TOTAL	151	100.0

		-			
1.5	Number	of peor	ole living	in the	household

1.6 Number of children

Descriptives		
Mean	3.6	
Mode	2	
Standard deviation	2.4	
Minimum	0	
Maximum	13	
Frequencies	Number	Percent
0-1	23	17.8
2-3	50	38.8
4-5	34	26.3
6-7	12	9.3
8-9	5	3.9
10-11	4	3.1
12-13	1	0.8
TOTAL	129	100.0

1.7 Education level

Frequencies	Number	Percent
Primary	83	52.5
Secondary	44	27.8
Tertiary/teacher training	10	6.3
University	6	3.8
No schooling	15	9.5
TOTAL	158	100.0

Education level cross-tabulated with sex

	Number		Per	cent
	Male	Female	Male	Female
Primary	32	51	54.2	51.5
Secondary	8	36	13.6	36.4
Tertiary	4	6	6.8	6.1
University	1	5	1.7	5.1
No schooling	14	1	23.7	1.0
TOTAL	59	99	100.0	100.0



Frequencies	Number	Percent	
Speak	5	3.2	
Read/write	24	15.2	
Speak/read/write	95	60.1	
None	34	21.5	
TOTAL	158	100.0	

1.8 Level of English comprehension

1.9 Main occupation of farmer

Frequencies	Number	Percent
Farmer	136	86.1
Teacher	3	1.9
Trader	1	0.6
Driver	3	1.9
Mason	2	1.3
Carpenter	1	0.6
Construction labourer	1	0.6
Farm labourer	2	1.3
Police	1	0.6
Civil servant	3	1.9
Businessman	3	1.9
Craftsman	1	0.6
None	1	0.6
TOTAL	158	100.0

1.10 Second occupation of farmer

Frequencies	Number	Percent
Farmer	13	8.3
Teacher	2	1.3
Driver	3	1.9
Mason	3	1.9
Carpenter	1	0.6
Cobbler	3	1.9
Tailor	2	1.3
Hawker	3	1.9
Health worker	2	1.3
Civil servant	1	0.6
Businessman	9	5.7
Craftsman	2	1.3
None	106	67.5
Other	7	4.4
TOTAL	157	100.0

1.11 Longui of time fiving in f	Valioui	
Descriptives		
Mean	17.8	
Standard deviation	15.4	
Minimum	1	
Maximum	80	
Frequencies	Number	Percent
0-4 years	30	19.0
5-9	28	17.7
10-19	38	24.1
20-29	28	17.7
30-39	19	12.0
40-49	9	5.7
>50 years	6	3.8
TOTAL	158	100.0

1.11 Length of time living in Nairobi

1.12 Length of time pra	ctising irrigation
-------------------------	--------------------

	0	
Descriptives		
Mean	7.1	
Standard deviation	8.1	
Minimum	1	
Maximum	50	
Frequencies	Number	Percent
0-4 years	77	49.0
5-9	44	28.0
10-19	23	14.6
20-29	7	4.5
30-39	4	2.5
40-49	1	0.6
>50 years	1	0.6
TOTAL	157	100.0

SECTION 2: HUMAN, SOCIAL AND ECONOMIC FACTORS

2.1 Main objective of growing inflated produce			
Frequencies	Number	Percent	
Main income	133	84.2	
Extra cash	14	8.9	
Cash for future investment	1	0.6	
Food	10	6.3	
TOTAL	157	100.0	

2.1 Main objective of growing irrigated produce

2.2 Household income sources

Activity	Number ranked 1-3	Rank score
Irrigated crops	157	2.82
Small business	30	0.45
Livestock	18	0.25
Salaried or waged work	11	0.18
Other	6	0.08
Rain-fed crops	2	0.03
Occasional labour	2	0.03
Hawker	2	0.03
Poultry	2	0.01
Providing local transport	0	0.00
Remittances from family members	0	0.00

Note: Maximum score = 3.00, minimum score = 0.00

2.3 Estimated household income (US\$)

Descriptives		
Mean	1724	
Standard deviation	2434	
Minimum	43	
Maximum	15920	
Frequencies	Number	Percent
<us\$250< td=""><td>21</td><td>15.1</td></us\$250<>	21	15.1
250-499	30	21.6
500-999	31	22.3
1000-1499	11	7.9
1500-1999	14	10.1
2000-2999	9	6.5
3000-4999	14	10.1
>=US\$5000	9	6.5
TOTAL	139	100.0

Note: US\$1 = KSh 62.2 (Interbank rate on 01/09/99)

2.4 Household possessions

Frequencies	Number	Percent	
Car	16	10.1	
Tractor	4	2.5	
Motorbike	1	0.6	
Bicycle	26	16.5	
TV	37	23.4	
Radio	147	93.0	
Fridge	15	9.5	



2.5 House construction			
Frequencies	Number	Percent	
Masonry	36	22.8	
Corrugated metal	82	51.9	
Adobe	12	7.6	
Mud	24	15.2	
Mains electricity	19	12.0	
Mains water	26	16.5	
Shared water standpipe	64	40.5	
Private well	4	2.5	

2.6 Number of rooms in house			
Descriptives			
Mean	2.7		
Standard deviation	1.5		
Minimum	1		
Maximum	7		
Frequencies	Number	Percent	
1	43	27.6	
2	49	31.4	
3	26	16.7	
4	18	11.5	
5	12	7.7	
6	6	3.8	
7	2	1.3	
TOTAL	156	100.0	

2.5 House construction

2.7 Was credit used when irrigation started?

Frequencies	Number	Percent	
Yes	7	4.5	
No	149	95.5	
TOTAL	156	100.0	

2.8 If yes, where was credit obtained?

Frequencies	Number	Percent
NGO	1	16.7
Friend	2	33.3
Co-operative	3	50.0
TOTAL	6	100.0

2.9 Is credit used now?

Frequencies	Number	Percent
Yes	0	0.0
No	158	100.0
TOTAL	158	100.0



Activity	Self	Spouse	Other	Exch-	Paid	Other
			HH	ange		
Land preparation	87.3	22.8	14.6	0.6	60.1	1.3
Planting/transplanting	89.9	20.9	10.1	0.6	46.2	0.6
Weeding	86.1	23.4	12.7	0.6	51.3	0.6
Applying manure	71.5	15.8	6.3	0.0	32.3	0.0
Applying agro-chemicals	77.2	15.8	3.8	0.0	28.5	0.0
Watering	88.0	20.9	8.9	0.0	32.9	0.0
Harvesting	89.2	77.8	10.8	0.6	39.9	1.3

2.10 Labour types and activities

Cross-tabulation of labour and sex

	Nu	mber	Per	rcent
	Male	Female	Male	Female
Land preparation	54	84	91.5	84.8
Planting/transplanting	56	86	94.9	86.9
Weeding	54	82	91.5	82.8
Applying manure	37	76	62.7	76.8
Applying agro-chemicals	43	79	72.9	79.8
Watering	55	84	93.2	84.8
Harvesting	55	86	93.2	86.9

SECTION 3: LAND INFORMATION

3.1 Is land farmed at more than one location?

Frequencies	Number	Percent
Yes	83	52.5
No	75	47.5
TOTAL	158	100.0

3.2 If yes, is the other land irrigated?

Frequencies	Number	Percent
Yes	43	36.4
No	75	63.6
TOTAL	118	100.0

3.3 Total rainfed land (ha)

Descriptives		
Mean	1.1	
Standard deviation	2.54	
Minimum	0.0	
Maximum	16.2	
Frequencies	Number	Percent
<0.1 ha	4	5.6
0.1-0.24	29	40.8
0.25-0.49	12	16.9
0.5-0.74	3	4.2
0.75-0.99	5	7.0
1.0-1.9	10	14.1
2.0-2.9	4	5.6
3.0-4.9	2	2.8
>=5.0 ha	2	2.8
TOTAL	71	100.0



3.4 Irrigated plot 1

3.4.1 Area (ha)		
Descriptives		
Mean	0.52	
Standard deviation	0.83	
Minimum	0.02	
Maximum	8.09	
Frequencies	Number	Percent
<0.1 ha	7	4.4
0.1-0.24	74	46.8
0.25-0.49	31	19.6
0.5-0.74	13	8.2
0.75-0.99	11	7.0
1.0-1.9	16	10.1
2.0-2.9	4	2.5
3.0-4.9	1	.6
>=5.0 ha	1	.6
TOTAL	158	100.0

3.4.2 Distance of plot 1 from house (km)

Descriptives		
Mean	1.4	
Standard deviation	2.0	
Minimum	0.0	
Maximum	15.0	
Frequencies	Number	Percent
<0.5 km	62	39.2
0.5-1	13	8.2
1-2	27	17.1
2-3	31	19.6
3-4	11	7.0
4-5	3	1.9
>5 km	11	7.0
TOTAL	158	100.0

3.4.3 Number of years farming plot 1

Descriptives		
Mean	7.8	
Standard deviation	9.9	
Minimum	1.0	
Maximum	55.0	
Frequencies	Number	Percent
<10 years	119	76.8
10-19	20	12.9
20-29	7	4.5
30-39	4	2.6
40-49	3	1.9
>50 years	2	1.3
TOTAL	155	100.0



3.4.4 Plot 1 owner	ship
--------------------	------

Frequencies	Number	Percent
Household	25	15.9
City Council	25	15.9
Government	28	17.8
Private	79	50.3
TOTAL	157	100.0

3.4.5 Current tenure of plot 1

Frequencies	Number	Percent
Owner	48	30.9
Share tenant	6	3.9
Cash tenant	23	14.8
Squatter	61	39.2
Other	17	11.0
TOTAL	155	100.0

3.4.6 Annual rent per ha, cash tenants (US\$)

Descriptives		
Mean	75.5	
Standard deviation	66.4	
Minimum	0.0	
Maximum	321.5	
Frequencies	Number	Percent
<us\$25 ha<="" td=""><td>7</td><td>25.0</td></us\$25>	7	25.0
25-49	5	17.9
50-74	3	10.7
75-99	6	21.4
100-149	4	14.3
150-199	2	7.1
300-499	1	3.6
TOTAL	28	100.0

3.4.7 Flooding of plot 1

Frequencies	Number	Percent
Never	54	42.9
Occasionally	46	36.5
Every year	26	20.6
TOTAL	126	100.0



5.4.6 Inigation season length (months per year)			
Frequencies	Number	Percent	
1 months	1	0.6	
2	1	0.6	
3	0	0.0	
4	0	0.0	
5	0	0.0	
6	2	1.3	
7	1	0.6	
8	8	5.1	
9	1	0.6	
10	0	0.0	
11	0	0.0	
12 months	143	91.1	
TOTAL	157	100.0	

control migation season reingen (montails per /ear)	3.4.8	Irrigation season	length	(months	per y	year)
---	-------	-------------------	--------	---------	-------	-------

3.4.9 Area of plot 2

Descriptives		
Mean	0.29	
Standard deviation	0.33	
Minimum	0.04	
Maximum	1.62	
Frequencies	Number	Percent
<0.1 ha	4	10.3
0.1-0.24	21	53.8
0.25-0.49	9	23.1
0.5-0.74	3	7.7
0.75-0.99	0	0.0
1.0-1.9	2	5.1
2.0-2.9	0	0.0
3.0-4.9	0	0.0
>=5.0 ha	0	0.0
TOTAL	39	100.0

3.4.10 Area of plot 3 (ha)

Descriptives		
Mean	0.29	
Standard deviation	0.32	
Minimum	0.05	
Maximum	0.81	
Frequencies	Number	Percent
<0.1 ha	1	20.0
0.1-0.24	2	40.0
0.25-0.49	1	20.0
0.5-0.74	0	0.0
0.75-0.99	1	20.0
1.0-1.9	0	0.0
2.0-2.9	0	0.0
3.0-4.9	0	0.0
>=5.0 ha	0	0.0
TOTAL	5	100.0



J.4.11 10tal alea Illigated (lla)			
Descriptives			
Mean	0.60		
Standard deviation	0.86		
Minimum	0.02		
Maximum	8.09		
Frequencies	Number	Percent	
<0.1 ha	5	3.2	
0.1-0.24	61	38.6	
0.25-0.49	40	25.3	
0.5-0.74	11	7.0	
0.75-0.99	11	7.0	
1.0-1.9	22	13.9	
2.0-2.9	6	3.8	
3.0-4.9	1	0.6	
>=5.0 ha	1	0.6	
TOTAL	158	100.0	

3.4.11 Total area irrigated (ha)

SECTION 4: WATER MANAGEMENT

4.1 Irrigation water source		
Frequencies	Number	Percent
City Council water	4	2.5
Stream/river	75	47.8
Dug-out	6	3.8
Well/borehole	6	3.8
Natural pool	2	1.3
Sewage water	46	29.3
Gutter (household runoff)	1	0.6
Other	1	0.6
River & sewage	10	6.4
Council & river	4	2.5
Council & sewage	2	1.3
TOTAL	157	100.0

4.2 Approximate distance from plot to source (m)

Descriptives		
Mean	53	
Standard deviation	270	
Minimum	0	
Maximum	2000	
Frequencies	Number	Percent
<50 m	144	91.7
50-249	6	3.8
250-499	2	1.3
500-999	1	.6
1000-2000	2	1.3
>=2000 m	2	1.3
TOTAL	157	100.0



4.5 Conveyance memou		
Frequencies	Number	Percent
Manual	27	17.1
Pumped	52	32.9
Manual/pump hire	1	.6
Council water	2	1.3
Gravity channel	55	34.8
Seepage	4	2.5
Manual & pumped	5	3.2
Manual & channel	8	5.1
Council water & channel	2	1.3
Pumped & channel	2	1.3
TOTAL	158	100.0
Manual	41	25.9
Pumped	60	38.0
Gravity	67	42.4
Council	10	6.3
TOTAL	178	112.6

4.3 Conveyance method

4.4 Field application method

Frequencies	Number	Percent		
Watering can at source	26	16.5		
Water can at field container	1	0.6		
Furrow/basin	62	39.2		
Hose pipe	25	15.8		
Hose & shower head	1	0.6		
Fixed sprinkler	13	8.2		
Watering can & furrow	17	10.8		
Watering can & hose pipe	5	3.2		
Furrow & hose pipe	8	5.1		
TOTAL	158	100.0		

4.5 Does access to water limit the cultivated area?

Frequencies	Number	Percent
Yes, source dries up	38	24.1
Yes, too much effort	19	12.0
No	101	63.9
TOTAL	158	100.0

4.6 Is yield reduced because of lack of water?

Frequencies	Number	Percent
Yes	75	47.5
No	83	52.5
TOTAL	158	100.0

4.7 Would you drink the water used for irrigation?

Frequencies	Number	Percent
Yes	43	27.2
No	115	72.8
TOTAL	158	100.0



	Number		Per	cent
	Drink, yes	Drink, no	Drink, yes	Drink, no
City Council water	3	1	75.0	25.0
Stream/river	24	51	32.0	68.0
Dug-out	2	4	33.3	66.7
Well/borehole	5	1	83.3	16.7
Natural pool	2	0	100.0	0.0
Sewage water	0	46	0.0	100.0
Gutter (household runoff)	0	1	0.0	100.0
Other	1	0	100.0	0.0
River & sewage	1	9	10.0	90.0
Council & river	4	0	100.0	0.0
Council & sewage	1	1	50.0	50.0

Cross-tabulation of water source and would you drink the irrigation water

4.8 Does water quality affect crop choice?

Frequencies	Number	Percent
Yes	24	15.4
No	132	84.6
TOTAL	156	100.0

4.9 Cost of water

4.10 Can as much water be applied as required?

Frequencies	Number	Percent
Yes	114	72.2
No	44	27.8
TOTAL	158	100.0

4.11 If no, what is the limiting factor?

Frequencies	Number	Percent
Cost of labour	4	8.7
Cost of pump hire/operation	1	2.2
Work too hard	4	8.7
Not enough water	32	69.6
Water quality	5	10.9
TOTAL	46	100.0



Equipment	Number owning	Percent owning	Mean number owned	Number borrowing	Percent borrowing
Panga	154	97.5	1.8	13	8.2
Jembe	149	94.3	2.6	21	13.3
Shovel	100	63.3	1.5	15	9.5
Watering can	72	45.6	1.3	12	7.6
Water hose	46	29.1	3.0	5	3.2
Sprinklers	25	15.8	6.9	2	1.3
Drippers	1	0.6	1.0	0	0.0
Pump (petrol/diesel)	45	28.5	1.1	9	5.7
Pump (hand/treadle)	7	4.4	1.3	0	0.0
Knap-sack sprayer	77	48.7	1.2	36	22.8
Bucket	84	53.2	1.8	10	6.3
PVC pipe	46	29.1	19.7	12	7.6
Borehole	9	5.7	1.1	0	0.0
Water barrel	2	1.3	2.0	0	0.0
Tractor	6	3.8	1.5	0	0.0

4.12 Equipment owned and borrowed

4.13 Knowledge of treadle pumps

Frequencies	Number	Percent
Yes	101	64.3
No	56	35.7
TOTAL	157	100.0

4.14 If yes, have you considered buying one?

Frequencies	Number	Percent
Yes	45	43.7
No	58	56.3
TOTAL	103	100.0

4.15 If no, why not?

Frequencies	Number	Percent
Too expensive	47	62.7
Too tiring	18	24.0
Too time consuming	5	6.7
Can't pump enough water	5	6.7
TOTAL	75	100.0


SECTION 5: CROPPING INFORMATION

5.1 Annual cropping pattern

Сгор	No of farms	Total area (ha)	Total income (US\$)	Income per ha (US\$)
Kales	81	30.11	25555	849
Tomatoes	45	23.11	50874	2201
Cabbage	21	12.58	13579	1079
Spinach	38	12.11	7656	632
Maize	28	11.60	755	65
French beans	7	8.90	13524	1520
Cowpeas	14	3.82	2965	776
Beans	7	3.40	637	187
Lettuce	8	2.94	2251	766
Courgettes	2	1.50	7743	5162
Bulb Onions	7	1.46	407	279
Egg plants	3	1.10	2288	2080
Amaranthus	4	1.10	1178	1076
Arrow roots	5	0.98	880	900
Cauliflower	3	0.91	1889	2070
Bananas	2	0.90	198	220
Broccoli	3	0.84	2399	2856
Nightshade	2	0.60	281	469
Sugar cane	4	0.51	653	1280
Capsicum	2	0.42	1003	2389
Pepper	2	0.32	1312	4100
Chinese cabbage	2	0.29	221	762
Celery	3	0.24	1246	5192
Coriander	2	0.12	56	457
Pegion peas	1	0.04	5	121
TOTAL		119.90	139553	694 (average)

5.1.1 Crops ranked by area irrigated



Сгор	No of farms	Total area (ha)	Total income	Income per ha
Tomatoes	45	23 11	50874	2201
Kales	81	30.11	25555	849
Cabbage	21	12.58	13579	1079
French beans	7	8.90	13524	1520
Courgettes	2	1.50	7743	5162
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Beans	5	3.40	637	187
Bulb Onions	7	1.46	407	279
Nightshade	2	0.60	281	469
Chinese cabbage	2	0.29	221	762
Bananas	2	0.90	198	220
Coriander	2	0.12	56	457
Pegion peas	1	0.04	5	121

5.1.2 Crops ranked by total gross income

Crop	No of farms	Total area (ha)	Total income	Income per ha
			(US\$)	(US\$)
Celery	3	0.24	1246	5192
Courgettes	2	1.50	7743	5162
Pepper	2	0.32	1312	4100
Broccoli	3	0.84	2399	2856
Capsicum	2	0.42	1003	2389
Tomatoes	45	23.11	50874	2201
Egg plants	3	1.10	2288	2080
Cauliflower	3	0.91	1889	2070
French beans	7	8.90	13524	1520
Sugar cane	4	0.51	653	1280
Cabbage	21	12.58	13579	1079
Amaranthus	4	1.10	1178	1076
Arrow roots	5	0.98	880	900
Kales	81	30.11	25555	849
Cowpeas	14	3.82	2965	776
Lettuce	7	2.94	2251	766
Chinese cabbage	2	0.29	221	762
Spinach	38	12.11	7656	632
Nightshade	2	0.60	281	469
Coriander	2	0.12	56	457
Bulb Onions	7	1.46	407	279
Bananas	2	0.90	198	220
Beans	5	3.40	637	187
Pegion peas	1	0.04	5	121
Maize	28	11.60	755	65

5.1.3 Crops ranked by gross income per ha

Cron	No of farms	Mean	St dev	Min	Max
Amaranthus	4	5 463	5 404	833	12.600
Arrow roots	5	6 272	5 619	75	13 889
Bananas	2	2,233	2 027	800	3 667
Beans	5	846	608	300	1 800
Broccoli	3	6 889	5 669	2 667	13 333
Bulb Onions	3 7	1 914	2,124	2,007	5 000
Cabbage	21	4.496	7.062	167	26.667
Cauliflower	3	5.333	4.619	0	8.000
Celerv	3	12.778	10.715	5.000	25.000
Chinese cabbage	2	12.731	17.350	463	25,000
Coriander	$\frac{1}{2}$	891	376	625	1.157
Courgettes	$\frac{1}{2}$	10.667	13,199	1.333	20.000
Cowpeas	14	3.171	2.722	500	8,400
Egg plants	3	1.288	1.688	0	3.200
French beans	7	3.928	3.893	500	12.000
Kales	82	7.232	6.870	0	24,500
Lettuce	8	5,296	4,304	208	12,500
Maize	28	2,701	2,453	450	13,333
Nightshade	2	1.458	884	833	2.083
Pegion peas	1	187		188	188
Pepper	2	10,500	6,364	6,000	15,000
Spinach	38	7,384	6,892	67	24,000
Sugar cane	4	4,511	3,524	1,667	9,600
Tomatoes	45	11,559	10,322	256	38,400

5.1.4 Crop yields (kg/ha)

5.1.5 Market prices (Ksh/kg)

Crop	Min of Ag	No of	Survey	St dev	Min	Max
	price	farms	mean			
Amaranthus	10.0	4	9.9	7.0	4.0	20.0
Arrow roots	15.0	5	21.3	13.8	3.1	40.0
Bananas	12.0	2	8.4	2.2	6.8	10.0
Beans	25.0	5	23.9	9.7	14.4	33.3
Broccoli	35.0	3	38.3	2.9	35.0	40.0
Bulb Onions	30.0	7	33.1	37.2	5.0	113.6
Cabbage	20.0	21	27.7	15.1	5.0	70.0
Cauliflower	25.0	3	30.0	7.1	25.0	35.0
Celery	40.0	3	48.3	46.5	10.0	100.0
Chinese cabbage	30.0	2	40.0	42.4	10.0	70.0
Corriender	25.0	2	35.0	21.2	20.0	50.0
Cougettes	15.0	2	12.0	11.3	4.0	20.0
Cowpeas	25.0	14	29.2	30.9	4.3	100.0
Egg plants	20.0	3	25.0	14.1	15.0	35.0
French beans	30.0	7	36.9	7.4	30.0	50.0
Kales	20.0	82	17.9	18.7	1.4	80.0
Lettuce	25.0	8	35.3	20.5	7.1	60.0
Maize	15.0	28	16.2	21.5	3.3	80.0
Nightshade	20.0	2	20.0	0.0	20.0	20.0
Pegion peas	30.0	1	40.0	-	40.0	40.0
Pepper	15.0	2	25.0	7.1	20.0	30.0
Spinach	25.0	38	19.5	17.8	2.9	80.0
Sugar cane	15.0	4	15.0	5.8	10.0	20.0
Tomatoes	20.0	45	10.8	6.5	3.1	31.3



Percentages	Comm. seed	Herbicide	Insecticide	Fungicide	Fertiliser	Farmyard manure
Amaranthus	38%	0%	75%	63%	25%	13%
Apples	-	-	-	-	-	-
Arrow roots	0%	0%	0%	0%	0%	22%
Avocado	-	-	-	-	-	-
Bananas	20%	20%	0%	0%	20%	60%
Beans	92%	8%	54%	38%	54%	62%
Beetroots	-	-	-	-	-	-
Broccoli	100%	0%	100%	100%	100%	100%
Bulb Onions	93%	13%	53%	53%	67%	87%
Cabbage	96%	12%	100%	76%	88%	96%
Capsicum	100%	50%	100%	100%	100%	100%
Carrots	100%	0%	100%	100%	100%	100%
Cassava	-	-	-	-	-	-
Cauliflower	100%	25%	100%	75%	75%	100%
Colory	100%	40%	60%	60%	100%	100%
Chinese cabbage	100%	-1070	50%	50%	100%	100%
Citrus	10070	070	5070	5070	10070	10070
Ciulus	-	-	- 2004	-	-	-
Corriender	100%	0%	80% 1000/	00% 50%	00%	00%
Cougettes	100%	0%	100%	50%	100%	100%
Cowpeas	95%	0%	95%	63%	26%	26%
Cucumber	-	-	-	-	-	-
Dill	-	-	-	-	-	-
Egg plants	100%	20%	100%	80%	40%	40%
Flowers	-	-	-	-	-	-
French beans	100%	0%	100%	100%	89%	100%
Fruit trees	-	-	-	-	-	-
Kales	99%	7%	85%	68%	63%	71%
Kay apple seedlings	-	-	-	-	-	-
Leek	-	-	-	-	-	-
Lettuce	100%	0%	90%	70%	90%	100%
Long celery	-	-	-	-	-	-
Lucern	100%	0%	0%	0%	0%	100%
Maize	89%	2%	36%	31%	38%	42%
Mangoes	-	-	-	-	-	-
Nappier grass	-	-	-	-	-	-
Nightshade	100%	0%	100%	100%	0%	0%
Oranges	-	-	-	-	-	-
Pawnaw	_	_	-	_	_	_
Peas	100%	100%	0%	0%	100%	100%
Perion near	67%	0%	67%	67%	0%	33%
Penner	100%	0%	100%	100%	100%	0%
Potetoos	500%	50%	100%	10070	500%	100%
Pumpking	30%	30%	0%	0%	30%	100%
Fullphills	-	-	-	-	-	-
Spinach	98%	5%	92%	63%	62%	/0%
Spring Onion	100%	0%	100%	100%	0%	0%
Star grass	-	-	-	-	-	-
Strawberry	-	-	-	-	-	-
Sugar cane	0%	0%	0%	0%	0%	25%
Sweet corn	-	-	-	-	-	-
Sweet potatoes	0%	0%	0%	0%	0%	0%
Tomatoes	99%	12%	91%	91%	78%	88%
Tree nursery	-	-	-	-	-	-
Vegetable seedlings	-	-	-	-	-	-
Water melon	-	-	-	-	-	-

5.2 Crop inputs



5.3 Formal extension advice received

Frequencies	Number	Percent
Yes	48	30.4
No	110	69.6
TOTAL	158	100.0

5.4 Are any crops stolen from the field?

Frequencies	Number	Percent
Yes	108	68.8
No	49	31.2
TOTAL	157	100.0

5.5 If yes, is it a major problem?

Frequencies	Number	Percent
Yes	71	48.6
No	75	51.4
TOTAL	146	100.0

5.6 Do you experience harassment?

Frequencies	Number	Percent
Yes	1	0.6
No	157	99.4
TOTAL	158	100.0

5.7 If yes, who from?

5.8 Has any equipment been stolen from the field?

Frequencies	Number	Percent
Yes	45	28.5
No	113	71.5
TOTAL	158	100.0

5.9 If yes, is it a major problem?

Frequencies	Number	Percent
Yes	27	25.5
No	79	74.5
TOTAL	106	100.0



SECTION 6: MARKETING

6.1 Do you take your produce to market?

Frequencies			_	a					
	Local	Nairobi	Local and Nairobi	Mombass	Other Kenya	Africa export	Other export	Total YE	Total NO
Take produce to market	34	27	13	1	0	0	0	75	83
Individuals buy from field	77	30	2	0	2	0	0	111	47
Middlemen buy from field	42	34	25	0	1	0	0	102	56
Contract with institution	0	5	0	0	0	0	0	5	153
Percentages									
Take produce to market	21.5	17.1	8.2	0.6	0.0	0.0	0.0	47.5	52.5
Individuals buy from field	48.7	19.0	1.3	0.0	1.3	0.0	0.0	70.3	29.7
Middlemen buy from field	26.6	21.5	15.8	0.0	0.6	0.0	0.0	64.6	35.4
Contract with institution	0.0	3.2	0.0	0.0	0.0	0.0	0.0	3.2	96.8

6.2 Do you market as:

Frequencies	Number	Percent
Individual	143	100.0
Member of informal group	0	0.0
Member of co-operative	0	0.0
TOTAL	143	100.0

SECTION 7/8:

7.1 Plans to extend irrigation

Frequencies	Number	Percent
This year	24	15.2
Next year	15	9.5
Sometime	95	59.5
Never	25	15.8
TOTAL	158	100.0

7.2 Constraints inhibiting irrigated production

Activity	Rank score
Water	1.15
Inputs	0.95
Crop damage	0.93
Theft	0.85
Labour	0.79
Land	0.31
Credit	0.28
Marketing	0.28

Note: Maximum score = 3.00, minimum score = 0.00

8.1 Farm appearance

Frequencies	Number	Percent
Good	46	29.1
Average	79	50.0
Poor	33	20.9
TOTAL	158	100.0







Literature review





HR WALLINGFORD LTD.

SMALL HOLDER IRRIGATION SCHEME DEVELOPMENT ORGANISATION (SISDO)

DOCUMENTATION

ON

PERI-URBAN IRRIGATION RESEARCH PROJECT IN NAIROBI

REPORT

AUGUST, 1999



Log Associates First Floor Pride Tower Woodvale Grove Westlands P.O. Box 29082 NAIROBI Tel: 441746, 448065 Fax : +254-2-448035 E-mail: log.associates@swiftkenya.com



PERI-URBAN IRRIGATION RESEARCH PROJECT IN NAIROBI

EXECUTIVE SUMMARY

This report presents the status of information available on peri-urban irrigation research in Nairobi, in line with the terms of reference given to the consultant **Log Associates** by the client **Small Holder Irrigation Scheme Development Organisation (SISDO)**, for **HR Wallingford.** The report contains summaries of documents and their sources, records of communication from institutions where documentation was not available and contact persons in the various institutions from which this information was obtained.

In compilation of this report, visits were made to libraries of relevant institutions. The Internet was also used. Published, unpublished, consultancy and other reports were reviewed. For each document reviewed, the following information is provided: Name of author, year of publication, location, title and journal in which it was found, annotations, detailed summary of the document and keywords.

From the study, a total of 51 documents were identified which contained information relevant to the study. In cases where there were no documents, interviews were conducted to establish whether there was any useful information to be gathered regarding this study. Ten documents were identified which had information on water quality monitoring of rivers and surface water bodies. Three persons who were interviewed also provided information on the same. Stream flow data for rivers in Nairobi is available from the Ministry of Water Development. 43 documents relevant to urban agriculture were identified and they contain information on the status urban agriculture in Nairobi, methods of irrigation used, successes and the constraints experienced by urban farmers. Some documents contain recent and on going studies and interventions by Non Governmental Organisations (NGOs) in the urban and peri-urban zones of Nairobi.

From the study, constraints of urban agriculture and irrigation were highlighted. The major ones being access to land and the lack of capital. The issue on usage of sewage water and solid waste in urban agriculture was found to be a health as well as an environmental hazard. The role and contribution of institutions involved in urban agriculture is mentioned in some of the documents reviewed. The need to address policy adjustment has been shown in order to improve the status of urban agriculture.

Generally, very few studies have been done on urban agriculture in Nairobi, hence information availability is limited. There is a lack of policies addressing urban agriculture and this poses difficulties for those willing to practice agriculture in the city. The Nairobi City Council (NCC) is also hampered in trying to control clean water distribution and sewage disposal. Most urban farmers are restricted to farming in the wet seasons because they do not practice irrigation. This is attributed, in part to the unwillingness of cultivators to expend capital and labour on improvements because of land tenure insecurity.

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LIST OF ABBREVIATIONS AND LOCATION SYMBOLS

ASC	African Studies Centre
DAO	District Agricultural Officer
ELR	Entwicking + Landlicher Raumm
KU	Kenyatta University
MAZINGIRA	Mazingira Institute
MOA	Ministry of Agriculture
NCC	Nairobi City Council
RELMA	Regional Land Management Unit
UOD	University of Dar-es-salaam
FAO	Food and Agriculture Organization
ATC	Appropriate Technology Centre
KARI	Kenya Agricultural Research Institute
WB	World Bank

1.0 INTRODUCTION

1.1 Preface

This report is on documentation relevant to peri-urban irrigation research in Nairobi. Summaries of documentation and information are presented, in line with the terms of reference from the client and *Smallholder Irrigation Scheme Development Organisation (SISDO)* acting for *HR Wallingford* to the consultant *Log Associates*.

The report contains the names of the authors and agencies responsible for generation of documents and data, the date of publication and a summary of the information contained in the document as well as the annotations and keywords of the studies.

1.2 Study Area

The data and information gathered was for the city of Nairobi and its environs. Nairobi is a city, financial and administrative capital, a province and the capital of Kenya. It was founded in the late 1890s as a British railroad camp on the Mombasa-Uganda (Kampala) railroad. From 1899 to 1905 it served as a British provincial capital.

In 1963 Nairobi became the capital city of independent Kenya and annexed neighbouring areas for its expansion. Today, Nairobi is a large, modern commercial and international business and tourist centre. There are many churches, mosques and temples where people of different faiths go to worship. Restaurants serve almost every kind of food, from local dishes to the most exotic to its metropolitan population.

The city of Nairobi is located at latitude 1 00 N and longitude 38 00 E. The average daytime temperature for the dry season is about 29° C. The mean temperature for the rest of the year is about 24° C. Night temperatures in Nairobi are cool with the mean annual nighttime temperature of about 9° C.

Nairobi has a diurnal rainfall pattern with the onset of the long rains in April. These long rains end in June and a long dry spell of about 3 months sets in. The short rains come in mid-September and end in late October. The annual average rainfall amount for Nairobi is about 880 mm.

The population of Nairobi as per the last census of 1989 was reported to be about 1.5 million people. Currently, it is estimated that the population of this city is well above the 2.0 million mark. This increase is mainly attributed to the migration of people in search of jobs in the city and high birth rate. Because of the rising population and the poorly performing Kenyan economy, many people residing in Nairobi, especially those in the low income areas with access to good arable land and water are known to engage in urban farming.

1.3 Terms of Reference

The Terms of Reference (TOR) of the study was to provide a report on documentation and information relevant to peri-urban irrigation research in Nairobi. The information should relate to the following themes:

- a) Water quality monitoring of rivers and surface water bodies in and around/greater Nairobi; monitoring of effluent discharges and the availability of stream flow data for rivers in and around Nairobi,
- b) Studies of urban agriculture within Nairobi,
- c) On-going and recently completed interventions or studies conducted by multilateral and bilateral donors, national and international NGOs relevant to the control, use and development of land and water resources in the urban and periurban zone of Nairobi, and
- d) Policy documents of Nairobi City Council that have relevance to informal urban agriculture and wastewater re-use and management now and in the future.

1.4 Methodology of the Study.

The information contained in this report was obtained using the following methods:

- . Visits to libraries and Documentation centres in the following institutions;
 - . Mazingira Institute
 - · RELMA
 - .· World Bank
 - .• Kenyatta University
 - . Ministry of Agriculture
 - Nairobi City Council; Water and Sewage Department
 - .· KARI Library (Kabete)
 - . FAO Library (Kenya)
 - . Ministry of Water Development (MOWD)
- . Through the Internet.

1.5 Background

Urban agriculture refers to food grown within a city or peri-urban area and produced directly for the market and/or household use. Urban agricultural activities include horticulture and livestock production among others. It also encompasses both formal and informal enterprises where formal urban industry includes market gardens, middle-income enterprises and large agribusinesses. Informal urban farming is dominated by low income farmers (over 50 percent of which are women) operating at a small scale (Smit et al, 1996).

The first major study of urban farming in Kenya was done in 1985 by Mazingira Institute. The study established that almost two thirds of all urban dwellers in the country were growing some subsistence food. 29 percent of all urban households also farmed in towns at the time. The survey also found that the larger the town, the smaller the urban farming plots.

Urban agriculture plays a significant role in enabling self sufficiency in food production in Nairobi and its environs (Lee-Smith & Memon,1994; Mwangi,1995; Omwega,1997). The need for irrigation to supplement the natural rainfall coupled with proper management of the water is essential in irrigated urban agriculture. Studies have also indicated the threat of industrial effluent and sewage water disposal to rivers in the provision of water for use in agriculture.



Proper waste disposal techniques have also been found to be lacking and therefore improvement of water quality is essential (Omwega,1997; Foeken & Mwangi,1998).

Security of land tenure has been pointed out as a major hindrance to the development of urban farming and so the necessity of a legal framework to improve on land security for the food production is essential(Lee-Smith,1998).

1.6 Maps and Photographs

During the study, several maps that are relevant to the study were identified. The maps show land use, areas in and around Nairobi where urban agriculture is practised, and agro-ecological zones. One photograph on use of solid waste in urban farming was also identified. The source and locations of these maps are included in the summaries of documentation.

1.7 Acknowledgements

We wish to acknowledge the following institutions whose cooperation and assistance made it possible to collect this information: The Mazingira Institute, World Bank Library, Kenyatta University - Appropriate Technology Centre, Kenya Agricultural Research Institute Library-Headquarters, Nairobi City Council-Water and Sewage Department, Ministry of Water-Development, Food and Agriculture Organisation Library and the Ministry of Agriculture.

2.0 FINDINGS

The consultant identified 51 documents pertinent to the study. The documents identified contained information in the following areas:

- . Water quality and Irrigation
- . Urban Agriculture
- . Involvement of Non Governmental Organisations
- . Use of waste water in Urban Agriculture

In summary, documents on water quality and irrigation contained information on standards of discharge of effluent into rivers, constraints that hinder irrigation activities in Nairobi and the methods of irrigation used. One of the major sources of irrigation water in Nairobi is sewage water which is obtained from burst sewer lines. Another source of water for irrigation is treated piped water meant for domestic use. Some farmers use water from the Nairobi river to irrigate their plots. Drought is cited as one of the constraints that confines urban agriculture to wet season only and hence the need for irrigation. Low levels of irrigation have also been attributed to the unwillingness of cultivators to expend capital and labour on improvements.

Annual Reports from the Ministry of Agriculture show divisions where urban agriculture is practised as well as the status of urban agriculture in Nairobi. The major constraint of urban agriculture is access to land. In some residential areas, the garden-city model has been laid out to prevent the use of these residential areas for urban agriculture. With time, rural-urban migration has led to an increase in urban agriculture in an effort to meet food requirements for the city dwellers. More women are engaged in farming than men. Urban agriculture has been viewed as a health hazard, this is mainly because of the use of sewage water, use of composed solid waste from Nairobi households and also the inappropriate use of agricultural inputs which are seen as a threat to drinking water sources through leaching and runoff.

Some of the Non Governmental Organisations that were mentioned in the documents and are involved in studies on urban agriculture are Regional and Land Management Unit, The Mazingira Institute, Undugu Society, Help Self Help Centre among others.

There are no policies of the Nairobi City Council on urban agriculture, urban policies seldom address urban agriculture. Some interested bodies such as the World Bank have sent proposals to the Nairobi City Council which would assist in setting out policies in this area. There is clearly a need for policy adjustment and to set up an institutional legal framework that will cater for the needs of urban farmers.



ITEM NUMBER	1		
AUTHOR	Njenga B. K.		
YEAR OF PUBLICATION	1997		
LOCATION SYMBOL	KU		
TITLE OF ENTRY	Urban Waste Management		
JOURNAL IN WHICH FOU	ND Ph.D. Thesis		
ANNOTATIONS			
DETAILS OF STUDY	Has highlighted that urban agriculture is a common activity in Nairobi. It points out that access to land is a major constraint to urban agriculture. It further states that availability of good compost is another limiting factor. Households that do not practice urban agriculture are willing to buy good compost which implies that they would start cultivating backyards once they obtain good compost. The study emphasised the necessity to carry out an extensive survey of cultivated plots and farms within the boundaries and in the immediate surrounding of Nairobi where the "Nairobians" are known to raise food for consumption within the city. Constraints to urban agriculture may be assessed through more detailed interviews with both participants and non-participants of the activity. The report mentions drought and poor maintenance of facilities for distributing and collecting water as having reduced reliability for public water supply. Poor waste management practices have contaminated Nairobi River. Surface water bodies are also increasingly being threatened with pollution (agricultural chemicals and industrial urban effluent).		
KEYWORDS	Constraints, Waste management, compost.		
ITEM NUMBER	2		
AUTHOR	Otieno Odongo & Partners, Gath and Wanjohi Consulting Engineers in Association with SWECO		
YEAR OF PUBLICATION	1998		
LOCATION SYMBOL	NCC (Eastleigh)		
TITLE OF ENTRY	NAIROBI MASTER PLAN REPORT, VOL III - Drawings and Maps		
JOURNAL IN WHICH FOU	ND Nairobi and Environs: Land Use 1995		

ANNOTATIONS	Мар		
DETAILS OF STUDY	The map shows Land use for the Nairobi area.		
KEYWORDS	Land Use		
ITEM NUMBER	3		
AUTHOR	Otieno Odongo & Partners, Gath and Wanjohi Consulting Engineers in Association with SWECO		
YEAR OF PUBLICATION	1998		
LOCATION SYMBOL	NCC (Eastleigh)		
TITLE OF ENTRY	NAIROBI MASTER PLAN FOR SEWER, SANITATION AND DRAINAGE; Third Nairobi Water Supply Project - Draft Master Plan Report, VOL II Appendices		
JOURNAL IN WHICH FOUN	ND Appendix 5.1: NCC Standards for Discharge into public sewers.		
ANNOTATIONS	pp 2		
DETAILS OF STUDY	Effluent standards for acceptance of wastewater discharge into public sewers (issued Feb 1970). Includes pH, Temperature, Oxygen absorbed, B.O.D levels, suspended solids, greases, oil, petrol, toxicity levels etc.		
KEYWORDS	Effluent, pH, Temperature		
ITEM NUMBER	4		
AUTHOR	Otieno Odongo & Partners, Gath and Wanjohi Consulting Engineers in Association with SWECO		
YEAR OF PUBLICATION	1998		
LOCATION SYMBOL	NCC (Eastleigh)		
TITLE OF ENTRY	NAIROBI MASTER PLAN FOR SEWER, SANITATION AND DRAINAGE; Third Nairobi Water Supply Project - Draft Master Plan Report, VOL II Appendices		
JOURNAL IN WHICH FOUN	ND Appendix 5.2: NCC Standards for Discharge into water courses.		
ANNOTATIONS	pp 2		

DETAILS OF STUDY	Effluent standards for direct discharge to natural water courses (issued 1970). Includes pH, Temperature, Oxygen absorbed, B.O.D levels, suspended solids, greases, oil, petrol, total Nitrogen excluding NO3, Mg/l, NH3, toxicity levels etc.	
KEYWORDS	Effluent, pH, oxygen, temperature	
ITEM NUMBER	5	
AUTHOR	Muthoni M. Mwangi	
YEAR OF PUBLICATION	1998	
LOCATION SYMBOL	RELMA	
TITLE OF ENTRY	URBAN FOOD PRODUCTION	
JOURNAL IN WHICH FOUN	ND Report of a workshop on East and Southern Africa Held in Nairobi, Kenya.	
ANNOTATIONS	pp 28 - 32	
DETAILS OF STUDY	The need for policy priorities to be founded on poverty alleviation among the urban poor is mentioned as necessary to improve food security and that urban food policy should therefore target the needs of poor urban households. Protection and security in access to public land is pointed out as a priority area for policy to enable poor urban farmers compete with more economically powerful food producers. Also mentions the institutional setting, technical aspects, policy needs to be guided and research.	
KEYWORDS	Food, production, protection, security.	
ITEM NUMBER	6	
AUTHOR	Muthoni M. Mwangi	
YEAR OF PUBLICATION	1998	
LOCATION SYMBOL	RELMA	
TITLE OF ENTRY	URBAN FOOD PRODUCTION	
JOURNAL IN WHICH FOUN	ND Report of a workshop on East and Southern Africa, held in Nairobi, Kenya.	
ANNOTATIONS	pp 19-20	

DETAILS OF STUDY	This report indicates that two thirds of urban households in Kenya are engaged in farming. Women (56 %) are more active than men (44 %) in urban agriculture. Urban cultivators are poor and middle aged with low education levels and have large families. According to the report, the targeted group is the urban poor and part of the rural landless. It also emphasises increased research in Kenyan urban agriculture.		
KEYWORDS	Kenya, Urban Farming.		
ITEM NUMBER	7		
AUTHOR	Smit Jac, Ralta Annu, Bernstein Janis.		
YEAR OF PUBLICATION	1996		
LOCATION SYMBOL	WB		
TITLE OF ENTRY	URBAN AGRICULTURE		
JOURNAL IN WHICH FOU	ND Urban Agriculture in Sub-sahara Africa		
ANNOTATIONS	pp 11 - 14		
DETAILS OF STUDY	The chapter looks at effects of urban population increase, effects of rural to urban migration and how it has caused unprecedented urban growth in Sub-saharan Africa, the nature and extent of Urban Agriculture and irrigation. It also mentions how in the Nairobi river flood plain slum dwellers plant fruit trees to prevent flood damage thus increasing efficiency of land use. Important references have been cited.		
KEYWORDS	Urban, land, irrigation.		
ITEM NUMBER	8		
AUTHOR	Smit Jac, Ralta Annu and Bernstein Janis.		
YEAR OF PUBLICATION	1996		
LOCATION SYMBOL	WB		
TITLE OF ENTRY	UBAN AGRICULTURE		
JOURNAL IN WHICH FOU	ND Constraints to Urban Agriculture		
ANNOTATIONS	pp 15 - 20		
DETAILS OF STUDY	The chapter reports constraints of Urban Agriculture such as inadequate institutional/legal frameworks, limited access to agricultural inputs and post-production services and inadequate		

	knowledge as well as technical staff. Important references have been cited.	
KEYWORDS	Constraints	
ITEM NUMBER	9	
AUTHOR	Freeman Donald B.	
YEAR OF PUBLICATION	1991	
LOCATION SYMBOL	MAZINGIRA	
TITLE OF ENTRY	A CITY OF FARMERS	
JOURNAL IN WHICH FOU	ND Chapter 5: Urban Food Production and Consumption in Six Kenyan Municipalities	
ANNOTATIONS	pp 49 - 53	
DETAILS OF STUDY	The chapter cites the use of fertilizer and irrigation in and around Nairobi. It avers that the use of fertilizer and irrigation is higher in Nairobi compared to other municipalities. This is attributed to improved knowledge and husbandry practices on the part on Nairobi's better educated population and superior access to funds and farm inputs.	
KEYWORDS	Irrigation, migration, practice	
ITEM NUMBER	10	
AUTHOR	Freeman Donald B.	
YEAR OF PUBLICATION	1991	
LOCATION SYMBOL	MAZINGIRA	
TITLE OF ENTRY	CITY OF FARMERS	
JOURNAL IN WHICH FOU	ND Chapter 7: Inner City Farmers and Suburban Cultivators; A comparison	
ANNOTATIONS	pp 64 - 70, 1 map	
DETAILS OF STUDY	The chapter presents results of a baseline survey that looked in detail	

The chapter presents results of a baseline survey that looked in detail at the status of urban Agriculture in Nairobi. Nairobi was divided into seven areas. The factors that were looked at in all these areas were the influence of gender, ethnicity, migration and affluence on Urban

	Agriculture. Long term use of land was associated with considerable capital improvement of the land including the growing of tree crops, the use of fertilisers and irrigation and practices to combat theft, erosion, water logging etc. This chapter also includes useful references.
KEYWORDS	Irrigation
ITEM NUMBER	11
AUTHOR	Freeman Donald B.
YEAR OF PUBLICATION	1991
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	A CITY OF FARMERS
JOURNAL IN WHICH FOUN	ND Chapter 10: Maize, Beans and What else? - Cultivation Practices of Nairobi's Urban Farmers
ANNOTATIONS	рр
DETAILS OF STUDY	Reports on the size of urban "shambas", types of crops, cultivation practices and implements and the form of cultivation assistance, irrigation is not common in the "shambas" occupying the open spaces of Nairobi. This does not appear to be a major impediment to annual rainfall of about 880mm. The chapter proposes use of irrigation to counter the effects of reliability of rainfall, drought or lateness of the planting rains. Various useful references have been cited.
KEYWORDS	Irrigation, crops, rainfall reliability, cultivation practices.
ITEM NUMBER	12
AUTHOR	Freeman Donald B.
YEAR OF PUBLICATION	1991
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	A CITY OF FARMERS
JOURNAL IN WHICH FOUN	ND Chapter 11: Harsh Realities - Impediments and Problems of Urban Agriculture
ANNOTATIONS	pp 97
DETAILS OF STUDY	The chapter cites the problems faced in Urban Agriculture including harassment of urban cultivators and loss of crops through theft and predation. Low levels of irrigation were encountered in the authors survey which reflects on unwillingness of cultivators to expend capital and labour on improvements.

KEYWORDS

ITEM NUMBER	13
AUTHOR	MOA
YEAR OF PUBLICATION	1988
LOCATION SYMBOL	MOA (Kilimo)
TITLE OF ENTRY	DAO's ANNUAL REPORT
JOURNAL IN WHICH FOUN	ND Crop Production
ANNOTATIONS	pp 13
DETAILS OF STUDY	Reports on crops grown under irrigation in Embakasi and Karen areas. It includes the acreage of these crops and periods in which they are grown, either during the short or long rains. It encourages farmers who can afford to irrigate to do so hence concentrate on off-season production to avoid production when the market is over-supplied.
KEYWORDS	Irrigation, crops, rainfall, market.
ITEM NUMBER	14
ITEM NUMBER AUTHOR	14 MOA
ITEM NUMBER AUTHOR YEAR OF PUBLICATION	14 MOA 1989
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL	14 MOA 1989 MOA (Kilimo)
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY	14 MOA 1989 MOA (Kilimo) DAO's ANNUAL REPORT
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUR	14 MOA 1989 MOA (Kilimo) DAO's ANNUAL REPORT ND Irrigation and Drainage
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN ANNOTATIONS	14 MOA 1989 MOA (Kilimo) DAO's ANNUAL REPORT ND Irrigation and Drainage pp 49 - 53
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN ANNOTATIONS DETAILS OF STUDY	14 MOA 1989 MOA (Kilimo) DAO's ANNUAL REPORT ND Irrigation and Drainage pp 49 - 53 Reports that sprinkler irrigation system takes the highest percentage of the methods being used. Few farmers along river banks practice furrow irrigation whereas drip irrigation is only used by farmers who can afford it. It shows that the methods being used, constraints and achievements of irrigation in Nairobi district.

ITEM NUMBER	15
AUTHOR	MOA
YEAR OF PUBLICATION	1990
LOCATION SYMBOL	MOA (Kilimo)
TITLE OF ENTRY	AO's ANNUAL REPORT
JOURNAL IN WHICH FOUN	D Irrigation and Drainage
ANNOTATIONS	pp 27 - 29, 31
DETAILS OF STUDY	Reports on the methods of irrigation used. Also shows the need for irrigation as a result of poor rainfall distribution.
KEYWORDS	Irrigation, methods, rainfall
ITEM NUMBER	16
AUTHOR	MOA
AUTHOR YEAR OF PUBLICATION	MOA 1983
AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL	MOA 1983 MOA (Kilimo)
AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY	MOA 1983 MOA (Kilimo) ANNUAL REPORT
AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN	MOA 1983 MOA (Kilimo) ANNUAL REPORT D Crop Production Services and Review of Crop Production
AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN ANNOTATIONS	MOA 1983 MOA (Kilimo) ANNUAL REPORT D Crop Production Services and Review of Crop Production Performance
AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN ANNOTATIONS DETAILS OF STUDY	MOA 1983 MOA (Kilimo) ANNUAL REPORT D Crop Production Services and Review of Crop Production Performance pp 10-12 Reports the need for encouraging farmers to install irrigation so as to provide water owing to lack of adequate rainfall in Dagoretti and Lower Makadara where horticulture growing has continued to increase. The list of horticultural crops grown is also provided and their areas of coverage. The report has also provided information on wet and dry weather as well as rainfall figures.



ITEM NUMBER	17
AUTHOR	MOA
YEAR OF PUBLICATION	1985
LOCATION SYMBOL	MOA (Kilimo)
TITLE OF ENTRY	ANNUAL REPORT, NAIROBI AREA
JOURNAL IN WHICH FOUN	D Annual Report
ANNOTATIONS	pp 2 - 4
DETAILS OF STUDY	Points out that only farmers with irrigation and those cultivating along river valleys are able to realise good short rain crops. Also provides a list of crops that have been grown under supplemental irrigation in the short rains especially kales, tomatoes, cabbages, spinach, citrus, bananas and flowers.
KEYWORDS	Irrigation, crops, rainfall

ITEM NUMBER	18
AUTHOR	Foeken D and Mwangi M. A.
YEAR OF PUBLICATION	1998
LOCATION SYMBOL	http://www.idrc.ca/cfp/reading03.e.html.(Internet)
TITLE OF ENTRY	FARMING IN THE CITY OF NAIROBI
JOURNAL IN WHICH FOUND ASC Working Paper	
ANNOTATIONS	pp 25, 6 Tables
DETAILS OF STUDY	The paper describes urban farming in Nairobi in all aspects. It also looks at land policies, the magnitude of urban farming in Nairobi since the 1980s, the urban farmers themselves, farming practices including the crops grown and the farming techniques. The importance of urban farming for the people involved, constraints and prospects for urban farming in Nairobi have been highlighted where urban agriculture is considered an environmental hazard because of the danger of soil erosion and the use of contaminated water for irrigation purposes. Important references have been cited.
KEYWORDS	Urban farming, crops, techniques, constraints

ITEM NUMBER	19
AUTHOR	Howard Humphreys and Partners
YEAR OF PUBLICATION	1986
LOCATION SYMBOL	NCC (Eastleigh)
TITLE OF ENTRY	3RD NAIROBI WATER SUPPLY PROJECT, DISTRIBUTION SYSTEM; SHORT TERM PLAN TO 1995 - VOLUME II APPENDICES
JOURNAL IN WHICH FOUN	ND Appendix B2
ANNOTATIONS	B2 - B5
DETAILS OF STUDY	Provides a listing of current land uses within each "development district" in Nairobi including the name of area and classification area in hectares.
KEYWORDS	Landuse.
ITEM NUMBER	20
ITEM NUMBER AUTHOR	20 Otieno Odongo & Partners, Gath and Wanjohi Consulting Engineers in Association with SWECO
ITEM NUMBER AUTHOR YEAR OF PUBLICATION	20Otieno Odongo & Partners, Gath and Wanjohi Consulting Engineers in Association with SWECO1998
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL	20 Otieno Odongo & Partners, Gath and Wanjohi Consulting Engineers in Association with SWECO 1998 NCC (Eastleigh)
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY	20 Otieno Odongo & Partners, Gath and Wanjohi Consulting Engineers in Association with SWECO 1998 NCC (Eastleigh) NAIROBI MASTER PLAN FOR SEWER, SANITATION AND DRAINAGE; Third Nairobi Water Supply Project - Draft Master Plan Report, VOL II Appendices
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN	20 Otieno Odongo & Partners, Gath and Wanjohi Consulting Engineers in Association with SWECO 1998 NCC (Eastleigh) NAIROBI MASTER PLAN FOR SEWER, SANITATION AND DRAINAGE; Third Nairobi Water Supply Project - Draft Master Plan Report, VOL II Appendices ND Appendix 5.3: Ministry of Land Reclamation, Regional and Water Development (MLRRWD) standards for discharge into public sewers
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN	20 Otieno Odongo & Partners, Gath and Wanjohi Consulting Engineers in Association with SWECO 1998 NCC (Eastleigh) NAIROBI MASTER PLAN FOR SEWER, SANITATION AND DRAINAGE; Third Nairobi Water Supply Project - Draft Master Plan Report, VOL II Appendices ND Appendix 5.3: Ministry of Land Reclamation, Regional and Water Development (MLRRWD) standards for discharge into public sewers Sheet 1,2,3
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN ANNOTATIONS DETAILS OF STUDY	20 Otieno Odongo & Partners, Gath and Wanjohi Consulting Engineers in Association with SWECO 1998 NCC (Eastleigh) NAIROBI MASTER PLAN FOR SEWER, SANITATION AND DRAINAGE; Third Nairobi Water Supply Project - Draft Master Plan Report, VOL II Appendices D Appendix 5.3: Ministry of Land Reclamation, Regional and Water Development (MLRRWD) standards for discharge into public sewers Sheet 1,2,3 Standards of Discharge into public sewers including pH, BOD, COD, Temperature etc. It also lists substances that should not be discharged into sewers.



ITEM NUMBER	21
AUTHOR	Otieno Odongo & Partners, Gath and Wanjohi Consulting Engineers in Association with SWECO
YEAR OF PUBLICATION	1986
LOCATION SYMBOL	NCC (Eastleigh)
TITLE OF ENTRY	NAIROBI MASTER PLAN FOR SEWER, SANITATION AND DRAINAGE; Third Nairobi Water Supply Project - Draft Master Plan Report, VOL II Appendices
JOURNAL IN WHICH FOUN	D Appendix 5.4: MLRRWD Standards for discharge into Natural water courses
ANNOTATIONS	Sheets 1, 2, 3
DETAILS OF STUDY	Standards of Discharge into natural water courses including pH, BOD, COD, Temperature etc. It also lists substances that should not be discharged into natural water courses.
KEYWORDS	Standards, discharge, substances.

ITEM NUMBER	22
AUTHOR	Sawio C.J
YEAR OF PUBLICATION	1993
LOCATION SYMBOL	UOD, http://www.idrc.ca/cfp/rep01_e.html(Internet).
TITLE OF ENTRY	URBAN AGRICULTURE RESEARCH IN EAST AND CENTRAL AFRICA: RECORD, CAPACITIES AND OPPORTUNITIES
JOURNAL IN WHICH FOUN	D Chapter 2: Regional Research Record: Strengths and weaknesses
ANNOTATIONS	pp 7- 9, 1 table
DETAILS OF STUDY	Mentions a major study that was undertaken in six towns by an NGO, the Mazingira institute. It documented in detail a variety of urban agricultural activities. Also includes findings of a follow up study in Nairobi and another urban agriculture study by Obara (1988) with reference to Nairobi that shows that Nairobi is capable of becoming self-sufficient and self-reliant in food production.
KEYWORDS	Urban agriculture, self-sufficiency, self-reliance.

ITEM NUMBER	23
AUTHOR	Lee-Smith and Lamba Davinder
YEAR OF PUBLICATION	1998
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	URBAN FOOD, FUEL AND SHELTER
JOURNAL IN WHICH FOUR	ND Paper prepared for Workshop on CFP: Lessons Learned from Projects in African Cities
ANNOTATIONS	pp 1 - 25
DETAILS OF STUDY	The paper reports how Mazingira Institute's interest in urban agriculture arose. It also mentions other institutions that have an interest in urban agriculture. Areas of impact, institutional capacity strengthening, gender sensitive insights, methodological advances and result utilization have been discussed. It presents an overall evaluation of the project. Useful references have been listed.
KEYWORDS	History, impact, institutions.
ITEM NUMBER	24
AUTHOR	Aipira Hoffman and Cockburn Charles
YEAR OF PUBLICATION	1994
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	URBAN FARMING IN LOW-INCOME CITIES
JOURNAL IN WHICH FOUR	ND A report prepared in connection with the first workshop on urban farming: Strategy for Food and Environmental Health in Low-income Cities
ANNOTATIONS	pp 1 - 26, 7 figures (Including Photos)
DETAILS OF STUDY	The paper reports that informal cultivation and animal raising increasingly being adopted as strategies for self reliance in food and fuelwood supply. Reasons leading to urban agriculture are also mentioned. It also mentions how urban farming has been ignored by policy makers and aid agencies. There are figures which show household containers that can serve as resources for urban food production particularly where space is limited. It cites a world wide survey of urban farming giving and example of Nairobi where solid and liquid waste is used for vegetable production in Nairobi.
KEYWORDS	Self reliance, energy, waste, resources.

ITEM NUMBER	25
AUTHOR	Ellis Frank and Sumbera James.
YEAR OF PUBLICATION	1997
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	FOOD PRODUCTION, URBAN AREAS AND POLICY RESPONSES
JOURNAL IN WHICH FOUN	ND Paper submitted to World Development
ANNOTATIONS	pp 1 - 35
DETAILS OF STUDY	The paper examines literature under the heading 'urban agriculture'. It sets out a desegregated view of food production in urban areas, emphasising the analytical and policy importance or rural urban interactions in resource and output markets as well as income transfers.
KEYWORDS	Farming, scope, participation, policies.
ITEM NUMBER	26
ITEM NUMBER AUTHOR	26 Lado Cleophas
ITEM NUMBER AUTHOR YEAR OF PUBLICATION	26 Lado Cleophas
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL	26 Lado Cleophas MAZINGIRA
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY	26 Lado Cleophas MAZINGIRA INFORMAL URBAN AGRICULTURE IN NAIROBI, KENYA.
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN	26 Lado Cleophas MAZINGIRA INFORMAL URBAN AGRICULTURE IN NAIROBI, KENYA.
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN ANNOTATIONS	26 Lado Cleophas MAZINGIRA INFORMAL URBAN AGRICULTURE IN NAIROBI, KENYA. D Problem or resource in development and land use planning? pp 257 - 265, 2 maps
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN ANNOTATIONS DETAILS OF STUDY	26 Lado Cleophas MAZINGIRA INFORMAL URBAN AGRICULTURE IN NAIROBI, KENYA. D Problem or resource in development and land use planning? pp 257 - 265, 2 maps Presents urban agriculture as an informal activity. This article examines the cultivation of open spaces in Nairobi, seemingly the only land available to the poor and landless classes of urban residents. It has maps showing the study area which is currently administered by the Nairobi City Commission. The article also mentions the expansion of urban agriculture vis a vis the city planners, distribution and socio- economic profile of urban cultivators, the urban agricultural land use rights and agricultural practices and consumption patterns. Also

ITEM NUMBER	27
AUTHOR	Omwega K. Asenath
YEAR OF PUBLICATION	1997
LOCATION SYMBOL	MAZINGIRA, RELMA
TITLE OF ENTRY	AN INFORMAL BASELINE SURVEY ON URBAN AGRICULTURE IN KENYA
JOURNAL IN WHICH FOU	ND Baseline survey report
ANNOTATIONS	pp 1 - 29, 3 tables
DETAILS OF STUDY	The report is an outcome of an informal baseline survey on urban agriculture in Kenya. It has specifically made an assessment of the situation in Kenyan urban agriculture with a focus on literature review. It has a comprehensive bibliography of published and unpublished work on urban agriculture, and an identification of key actors (institutions and NGOs) in urban agriculture in the country as well as an evaluation of the legal policies affecting urban agriculture.
KEYWORDS	Literature review, bibliography.
ITEM NUMBER	28
AUTHOR	Lee-Diana Smith and Lamba Davinder
YEAR OF PUBLICATION	1991

LOCATION SYMBOL MAZINGIRA

TITLE OF ENTRY THE POTENTIAL OF URBAN FARMING IN AFRICA

JOURNAL IN WHICH FOUND Article published for ECODECISION, December 1991

ANNOTATIONS pp 37 - 40

DETAILS OF STUDY Reports that urban farming has for a long time been ignored by planners and researchers. It also shows that plots for farming in the capital (Nairobi) are less than a quarter of the size of those found in other towns of Kenya. The most important input is reported to be water and is more easily obtained in towns than rural areas and used by 45 % of urban farmers. 71 % use piped water supply and others dig furrows or carry water form rivers. 87 % of them use piped town water usually carried from the source in cans and buckets.

KEYWORDS

Inputs, plots.
ITEM NUMBER	29
AUTHOR	Lee-Smith Diana and Memon Pyar Ali
YEAR OF PUBLICATION	1993
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	URBAN AGRICULTURE IN KENYA
JOURNAL IN WHICH FOUN	D Analysis of the characteristics of urban agriculture in Kenya, based on recent survey by Mazingira Institute
ANNOTATIONS	pp 25 - 41, 1 map
DETAILS OF STUDY	Incidence of urban farming is shown to be highest among lower income people. Majority of urban farmers are women with the proportion of women being higher in towns. Urban productivity is also higher and is consistent with Nairobi farmers higher use of inputs on smaller plots. Higher usage of water by urban farmers shows the advantage of urban over rural farming. Percentages of urban farmers using various methods of irrigation have been given.
KEYWORDS	Farming, inputs, methods.

ITEM NUMBER	30
AUTHOR	Lee-Smith Diana
YEAR OF PUBLICATION	1998
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	PROGRAMME INITIATIVE
JOURNAL IN WHICH FOUN	ND CFP Report No. 22
ANNOTATIONS	pp 5 - 20
DETAILS OF STUDY	Reports female restrictions and competing uses as constraints to food production on unbuilt public land or private land. Women's access to land indicated as being constrained by customary laws coupled with the risk of leaving a home or field unattended and transportation costs. Gender issues on urban farming is discussed. A detailed bibliography of publications in urban farming is presented.
KEYWORDS	Restrictions, access, laws, gender, bibliography.

ITEM NUMBER	31
AUTHOR	Mwangi A. M
YEAR OF PUBLICATION	1995
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	THE ROLE OF URBAN AGRICULTURE FOR FOOD SECURITY IN LOW INCOME AREAS IN NAIROBI
JOURNAL IN WHICH FOUN	ND FOOD AND NUTRITION STUDIES PROGRAMME. REPORT No.54/1995
ANNOTATIONS	pp 40 - 50
DETAILS OF STUDY	Presents an overview in farming in the City of Nairobi, plot locations and sizes are presented in tabular form for Nairobi area. Report indicates that plots are located along the Nairobi River. Access to land indicated as a hindrance to urban farming practice. The type of crops grown is presented as well. Presents reason for urban agriculture as being mainly for home consumption, since most farmers are reported as having taken urban agriculture because they needed food. Urban farming practices in context of access to farming land, labour, crops grown, inputs and problems faced are discussed.
KEYWORDS	Farming, city, plot locations, crops, land, labour, problems
ITEM NUMBER	32
AUTHOR	Diana Lee-Smith
YEAR OF PUBLICATION	1998
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	AFRICAN URBAN AGRICULTURE POLICY: ISSUES AND PRACTICES
JOURNAL IN WHICH FOUN	ND INTERNATIONAL CONFERENCE ON URBAN AGRICULTURE POLICY, SOUTH AFRICA
ANNOTATIONS	pp 1 - 16
DETAILS OF STUDY	Report explains why Urban Agriculture is needed. Indicates that one third of urban households grow food in Kenyan towns e.g Nairobi and that 40% of urban farmers would starve if it stopped from farming practices. Kenya urban agriculture pointed out as a significant phenomenon bearing upon the food security of the urban people. Urban agriculture is reported as being practised also by high and middle income households who own more urban land e.g from backyard gardens. Main reason for urban agriculture is indicated as

	productivity of urban farm plots is highest in Nairobi where average lot size is smallest.
KEYWORDS	Farming, practice, garden, policy, management.
ITEM NUMBER	33
AUTHOR	Lee-Smith Diana et al
YEAR OF PUBLICATION	1987
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	URBAN FOOD PRODUCTION AND THE COOKING FUEL SITUATION IN URBAN KENYA
JOURNAL IN WHICH FOU	ND National Report of Survey
ANNOTATIONS	pp 136 - 181
DETAILS OF STUDY	Presents the source of irrigation water in Nairobi as being from treated piped supply. Mean distance from shamba to water source is also presented. Water is indicated as being conveyed by means of buckets and watering cans. Report also provides the proportion of farmers who irrigate their crops and their sources of water. Harassment of farmers by the municipal authorities over the use of municipal water considered illegal is discussed. Most urban farmers are reported as not belonging to farmers organisations which are suspected of being run by corrupt officials. Access to adequate water for irrigation indicated as a constraint to urban agriculture.
KEYWORDS	Irrigation, water, supply, crops, organisations, corruption.
ITEM NUMBER	34
AUTHOR	Lee-Smith D, Memon P. A
YEAR OF PUBLICATION	1994
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	CITIES FEEDING PEOPLE; An examination of Urban Agriculture in East Africa
JOURNAL IN WHICH FOU	ND Urban Agriculture in Kenya
ANNOTATIONS	pp 67 - 84

DETAILS OF STUDY	The chapter discusses the political economy of urban farming in Kenya, urban crop farming inputs and commodity exchange, urban livestock, nutrition and policy implications. Boundaries of urban areas were carefully defined by the administration to avoid existing areas of subsistence farming and settlement. Residential areas like Nairobi were laid out on the basis of garden-city models. It shows that higher usage of water was recorded in Nairobi.
KEYWORDS	Urban Agriculture, Kenyan policy.

ITEM NUMBER	35
AUTHOR	Dennery P
YEAR OF PUBLICATION	1995
LOCATION SYMBOL	WAU
TITLE OF ENTRY	Inside Urban Agriculture
JOURNAL IN WHICH FOU	ND M.Sc Thesis
ANNOTATIONS	pp 1 - 3
DETAILS OF STUDY KEYWORDS	Explored food production aspects at individual, household and community level for urban food producers and their households in Kibera, a large informal settlement of Nairobi. The study investigated how food producers with limited material and monetary resources engaged in urban agriculture and presents factors affecting urban food producers e.g labour availability, insecure land tenure risks, theft and land degradation. Urban agriculture, benefits, problems, constraints.
ITEM NUMBER	36
AUTHOR	Dennery P
YEAR OF PUBLICATION	1996
LOCATION SYMBOL	ELR
TITLE OF ENTRY	URBAN AGRICULTURE IN INFORMAL SETTLEMENTS
JOURNAL IN WHICH FOU	ND Entwicklung + Landlicher Raum No. 6/96
ANNOTATIONS	pp 1 - 5

DETAILS OF STUDY	Presents the benefits of urban food production and its role in poverty alleviation. Refers to Kibera slums, Nairobi. Locations of plots, cropping seasons, crops grown and points out the use of sewage water to irrigate plots. Highlights problems and constraints to urban farming e.g eviction, crop thefts, inadequate rainfall, disease or insect pests etc. Study explains the value of urban agriculture in meeting urban food needs. Intensity of land tenure hinted as a setback to producer incentive to engage in appropriate land husbandry practices e.g Soil conservation.
KEYWORDS	Urban agriculture, benefits, problems, constraints.
ITEM NUMBER	37
AUTHOR	FAO
YEAR OF PUBLICATION	1997
LOCATION SYMBOL	FAO, www.fao.org/unfao/bodies/COAG/COAG15/X0076e.htm
TITLE OF ENTRY	URBAN & PERI-URBAN AGRICULTURE
JOURNAL IN WHICH FOU	ND FAO Publication
ANNOTATIONS	pp 8-11
DETAILS OF STUDY	Presents ways by which urban and peri-urban agriculture issues may be addressed. Emphasises the need to recognize rapidly changing urban conditions which influence the choice of land allocation among the competing needs which include urban agriculture. The role of policy decisions and political interests in the land allocation is mentioned. Water quality risk to urban agriculture practice is discussed. Small scale irrigation using proper water quality management pointed out as measure of dealing with problem of water quality risks activity from intensive agriculture in peri-urban areas. Inappropriate use of agricultural inputs hinted as a threat to drinking water source through leaching as runoff. Efficiencies in urban food production achieved by making productive use of underutilised vacant land, treated wastewater and recycled waste.
KEYWORDS	Waste, agriculture, policy, land allocation, water quality, irrigation.
ITEM NUMBER	38
AUTHOR	Peters K.
YEAR OF PUBLICATION	1998
LOCATION SYMBOL	MAZINGIRA, http://www.cityfarmer.org/NairobiCompost.html

TITLE OF ENTRYCOMMUNITY- BASED WASTE MANAGEMENT AND INCOME
GENERATION IN LOW-INCOME AREAS: A Case Study of
Nairobi, Kenya

JOURNAL IN WHICH FOUN	A Case Study
ANNOTATIONS	pp 38, References 131, Pictorial Illustrations 16
DETAILS OF STUDY	The report presents findings on application of composed solid waste from Nairobi households to farms in and around Nairobi, among other findings. However, no mention of irrigation is contained in the report. Useful references and pictorial illustrations are contained therein.
KEYWORDS	Composed solid waste

ITEM NUMBER	39	
AUTHOR	Smit Jac	
YEAR OF PUBLICATION	1996	
LOCATION SYMBOL	http://www.idrc.ca/cfp/rep18_e.html (Internet)	
TITLE OF ENTRY	URBAN AGRICULTURE, PROGRESS AND PROSPECT: 1975 - 2005	
JOURNAL IN WHICH FOUND CFP Report Series No. 18		
ANNOTATIONS	pp 2, 5 - 11	
DETAILS OF STUDY	Report begins by providing a global overview of urban agriculture and its role in the agricultural industry. Quotes studies on urban waste as an input to urban agriculture, urban food distribution systems and urban food security. Undugu society of Kenya is mentioned as being one of the community organisations active in supporting urban farming. Indicates the proportion of urban households practising urban farming in Nairobi, Kenya. NGOs and community organisations active in supporting urban agriculture are indicated. Discusses policy issues in urban agriculture and Kenya is mentioned as a country where urban agriculture is common.	
KEYWORDS	Agriculture, urban, organisations, food policy.	

ITEM NUMBER	40
AUTHOR	Lamba Davinder
YEAR OF PUBLICATION	1993
LOCATION SYMBOL	MAZINGIRA, http://www.idrc.ca/cfp/rep02_e.html (Internet)
TITLE OF ENTRY	URBAN AGRICULTURE RESEARCH IN EAST AFRICA
JOURNAL IN WHICH FOUN	ND CFP Series Report No. 2
ANNOTATIONS	pp 5, 17
DETAILS OF STUDY	Study found out that urban farming takes place on land in transitional use or in marginal quarters where crop security is an issue. The study points out the need to support organisations involved in urban farming. Indicates urban farming as a neglected area in Kenya. Fresh vegetables produced by Kenyan urban farmers indicated as improving diet in urban centres. Reports on urban agricultural practices, constraints and suggestions for improvement.
KEYWORDS	Marginal security, crop, urban farming, vegetables, constraints, improvement.
ITEM NUMBER	41
ITEM NUMBER AUTHOR	41 Sawio Camillus J.
ITEM NUMBER AUTHOR YEAR OF PUBLICATION	41 Sawio Camillus J. 1993
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL	41 Sawio Camillus J. 1993 MAZINGIRA, http://www.idrc.ca/cfp/rep01_e.html (Internet)
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY	41 Sawio Camillus J. 1993 MAZINGIRA, http://www.idrc.ca/cfp/rep01_e.html (Internet) URBAN AGRICULTURE RESEARCH IN EAST AND CENTRAL AFRICA: RECORD CAPACITIES AND OPPORTUNITIES
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN	 41 Sawio Camillus J. 1993 MAZINGIRA, http://www.idrc.ca/cfp/rep01_e.html (Internet) URBAN AGRICULTURE RESEARCH IN EAST AND CENTRAL AFRICA: RECORD CAPACITIES AND OPPORTUNITIES ND CFP Report Series No. 1
ITEM NUMBER AUTHOR YEAR OF PUBLICATION LOCATION SYMBOL TITLE OF ENTRY JOURNAL IN WHICH FOUN ANNOTATIONS	41 Sawio Camillus J. 1993 MAZINGIRA, http://www.idrc.ca/cfp/rep01_e.html (Internet) URBAN AGRICULTURE RESEARCH IN EAST AND CENTRAL AFRICA: RECORD CAPACITIES AND OPPORTUNITIES ND CFP Report Series No. 1 pp 7 - 9

and idea of idle resources.

KEYWORDS

Urban cultivators, activities, farming, resources.

ITEM NUMBER	42
AUTHOR	Njuguna Esther M. and Andima Dymphina
YEAR OF PUBLICATION	
LOCATION SYMBOL	KARI Headquarters
TITLE OF ENTRY	URBAN AGRICULTURE IN KENYA
JOURNAL IN WHICH FOUN	ND Research Paper
ANNOTATIONS	pp 10 - 19
DETAILS OF STUDY	Identifies irrigated cultivation as a class in urban agriculture. Rainfed cultivation is practised. Points out that cultivation is widespread in the Kenyan cities and towns Nairobi included and that value of crops grown in urban areas represents a considerable contribution to national agricultural production. Indicates that urban policies seldom address urban farmers needs. Gives the history of urban agriculture in Kenya, urban agricultural practices, urban agricultural use and governing rules, institutions involved. Mentions the use of sewage water in irrigation to support cultivation using the water from Kayole and Komarock estates in Nairobi, which is done by interfering with the sewage system. Provides a brief report on irrigation management and control of water from the Kayole and Komarock estates. Indicates the use of water from Nairobi river for irrigation.
KEYWORDS	Water management, cultivation, practices, landuse.
ITEM NUMBER	43
AUTHOR	Freeman Donald B.
YEAR OF PUBLICATION	1991
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	A CITY OF FARMERS
JOURNAL IN WHICH FOUN	D Chapter 13: The Importance of Urban Agriculture To the Community and the Nation
ANNOTATIONS	pp 111 - 122
DETAILS OF STUDY	The chapter describes ways in which urban agriculture contributes to the community and derives economic significance therefrom. Urban agriculture also contributes to National development. It also reports that urban agriculture is seasonal in the open spaces of Kenya's cities, implying that imports of food from rural areas must be increased at

times of the year when local subsistence production is not taking place. Lack of irrigation is given as a primary reason for this confinement of cultivation to the rainy season.

KEYWORDS Irrigation, season

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ITEM NUMBER	44
AUTHOR	Lee-Smith Diana and Memon Pyar Ali
YEAR OF PUBLICATION	1994
LOCATION SYMBOL	MAZINGIRA
TITLE OF ENTRY	URBAN AGRICULTURE IN KENYA
JOURNAL IN WHICH FOU	ND CFP
ANNOTATIONS	pp 67 - 84
DETAILS OF STUDY	Study analyses the characteristics of urban agriculture in Kenya within a wider socio-economic context based on a study by Mazingira Institute. It also raises questions or policy for sustainable urban development. Points out that most urban farmers produce food for consumption. Role of women ignored which results into current policy failures. Study also examines the significance of urban farming sector and related policy implications. Report indicates that boundaries of the urban areas have been carefully defined. Groups of urban farmers identified in report. Inputs to urban farming indicated as low. The report quotes piped water as being used to water crops hence a possible need for irrigation.
KEYWORDS	Socio-economic, sustainable, women, policy, farmers, urban, water.
ITEM NUMBER	45
AUTHOR	Obiero C.C
YEAR OF PUBLICATION	
LOCATION SYMBOL	KU (ATC)
TITLE OF ENTRY	THE QUALITY OF THE WATER OF THE UPPER ATHI CATCHMENT
JOURNAL IN WHICH FOU	ND Ph.D Proposal
ANNOTATIONS	pp iv, 1, 5, 7 (1-10)

DETAILS OF STUDY	The study proposed to sample suitable water, groundwater, rainwater to be collected from representative sites of the upper Athi Catchment. These are to be subjected to analytical tests to determine their physical, chemical and biological properties and results should be compared to standards set by KBS and WHO. The change of quality due to urbanization and agricultural use are to be inferred. States that agricultural use of water round the urban centres has led to adverse effects on rainfall water. Study covers Nairobi river. It includes investigations of levels of chemical and physical components of water, water quality changes due to agricultural activities and monthly variation of water quality. Report provides references on relevant work e.g on deterioration of water quality in Nairobi river.	
KEYWORDS	Standards, agricultural, quality, water, urbanization.	
ITEM NUMBER	46	
AUTHOR	Gatundu M. K	
YEAR OF PUBLICATION	1977	
LOCATION SYMBOL	KARI	
TITLE OF ENTRY	FUNDING IRRIGATION DEVELOPMENT IN KENYA	
JOURNAL IN WHICH FOUR	ND Irrigation and Technology transfer in support of food security: Proceedings of a subregional workshop, Harare, Zimbabwe	
DETAILS OF STUDY	Points out reasons for creation of the Small Holder Irrigation Development Organization as being to manage revolving fund for irrigation development and provides lessons learnt from the organization	
KEYWORDS	Irrigation, development	
ITEM NUMBER	47	
AUTHOR	Schnurr I Holtz S	
VEAR OF PURI ICATION	1008	
LAR OF FUELCATION	KARI	
TITLE OF ENTRY		
IIILE OF ENIKY	ENVIRONMENTAL, SOCIAL AND ECONOMIC POLICIES	
JOURNAL IN WHICH FOUND Policy and Planning		

ANNOTATIONS	pp 3 - 4
DETAILS OF STUDY	Recounts the risks and benefits from integrating environmental, social and economic policies including supplying clean water to the citizens of Nairobi.
KEYWORDS	Water, policies, benefits

ITEM NUMBER	48	
AUTHOR	FAO Publication	
YEAR OF PUBLICATION	1995	
LOCATION SYMBOL	FAO	
TITLE OF ENTRY	GEOGRAPHY, POPULATION AND WATER RESOURCES (KENYA: COUNTRY PROFILE)	
JOURNAL IN WHICH FOUND Irrigation in Africa - Water Report		
ANNOTATIONS	pp 157 - 161	
DETAILS OF STUDY	Report points out that there is underutilisation of both water resources and irrigation land potential and so limited demand for irrigation using treated effluent. Also mentioned in the document is the prison farms scheme on the Athi-river, re-using treated water from the Nairobi treatment works. Sources of information relating to irrigation development are also referenced e.g Atlas of Irrigation and Drainage in Kenya.	
KEYWORDS	Water, resources, irrigation, land potential, effluent treatment	

ITEM NUMBER	49
AUTHOR	MOA
YEAR OF PUBLICATION	1984
LOCATION SYMBOL	MOA (Kilimo)
TITLE OF ENTRY	ANNUAL REPORT
JOURNAL IN WHICH FOUND Horticulture	
ANNOTATIONS	pp 2

DETAILS OF STUDY	Less horticultural activities therefore horticultural crops need a lot of water. Farmers near river valleys continued to water their crops with little water available in streams. Those with boreholes or alternative water sources continued to irrigate crops	
KEYWORDS	Horticulture, activities, water.	
ITEM NUMBER	50	
AUTHOR	MOA	
YEAR OF PUBLICATION	1991	
LOCATION SYMBOL	MOA (Kilimo)	
TITLE OF ENTRY	ANNUAL REPORT	
JOURNAL IN WHICH FOUN	D Irrigation and Drainage	
ANNOTATIONS	pp 23 - 25	
DETAILS OF STUDY	Shows divisions where irrigation activities were carried out. The main irrigation methods and sources of water including dams, rivers, boreholes, city comission water and sewage. Also lists major crops grown under irrigation and the purposes e.g For export and local market and fodder crop production among others. The report has major achievements in irrigation and drainage in terms of number of farmers irrigating, those recruited for pump loaning scheme and general awareness of what irrigation and drainage branch can do for farmers in Nairobi. It also includes constraints faced and the project status.	
KEYWORDS	Activities, irrigation, crops, achievements, constrains, project status.	
ITEM NUMBER	51	
AUTHOR	Mbatia E. D. M	
YEAR OF PUBLICATION		
LOCATION SYMBOL	MOA (Hill Plaza)	
TITLE OF ENTRY	DISTRICT PROFILE REPORT	
JOURNAL IN WHICH FOUND Proposal for District Profile Report		
ANNOTATIONS	pp 7, 1 map, 2 tables	
DETAILS OF STUDY	The report is indicated as being important in aiding gathering of vital data in the design of various irrigation systems in Nairobi.	

Information on climate, soils and hydrology is provided. Potential areas for irrigation are identified and sources of water are indicated. The number of farmers practising irrigation in the indicated area is also given. The report concludes that there is a serious farming community in the surrounding area of the city, which caters for both local and export markets and therefore determination of actual potential and how to exploit it will contribute to improvement of life for various groups of farming communities. Maps showing the Agroecological zones in Nairobi, area divisions is available in the document.

KEYWORDS Irrigation, potential, water, markets, improvement, life.

4.0 LIST OF CONTACT PERSONS

- 1. Nairobi City Council, Kabete Water Works
 - Mr. Malwa (Chief Chemist)
- 2. Nairobi City Council, Water and Sewage Department
 - Mr. Moses Otieno(Assistant Engineer)
- 3. University of Nairobi, Geography Department
 - Prof. B. A. Obara
- Prof. R. A. Obudho
- 4. Ministry of Agriculture, Irrigation and Drainage Branch
- R.O.W. Nyandega (Irrigation Engineer)
- 5. Kenyatta University, Appropriate Technology Centre
- Dr. B. K. Njenga
- Mr. C. C. Obiero
- 6. Mazingira Institute
- Davinder Lamba (Executive Director).
- 7. Regional Land Management Unit
 - Alex Oduor (Documentation Officer)

5.0 DETAILS OF PERSONAL COMMUNICATION

ITEM NUMBER	Ι	
CONTACT PERSON	Prof. D. Obara	
LOCATION SYMBOL	University of Nairobi (Geography Department)	
DETAILS OF COMMUNICATION	He has been involved in irrigation development projects in and around Nairobi. Pointed out the need to involve the City Council in any irrigation development activities in Nairobi. He mentioned that NCC has a master plan for the Nairobi city in which information relating to land use (land use map) is available.	
KEYWORDS	Irrigation, development, land use.	
ITEM NUMBER	П	
CONTACT PERSON	J. K. Waititu (Assistant Director)	
LOCATION SYMBOL	Ministry of Water Development	
DETAILS OF COMMUNICATION	The Ministry of Water Development keeps all data on river flow for all rivers in and around Nairobi. The information is made available on request in writing. The request is to be in the form of a letter addressed to the Permanent Secretary, MOWD specifying the precise information needed. Information is also available on all water quality monitoring for rivers in and around Nairobi.	
KEYWORDS	River flow, water, quality.	
ITEM NUMBER	ш	
CONTACT PERSON	R. O. W. Nyandega (Irrigation Engineer)	
LOCATION SYMBOL	Ministry of Agriculture (Hill Plaza)	
DETAILS OF COMMUNICATION	Has pointed out that urban farming irrigation activities in Nairobi and its environs is carried out using sewage water. Areas in which urban agriculture is practiced include Kiambu, Langata, Njiiru and Karen. He hinted that more information could be available at the DAO's office, Nairobi in the form of reports (Annual Reports), where also more information may be obtained on farmers, status of irrigation, crops grown and areas of land involved.	
KEYWORDS	Irrigation, agriculture, urban, sewage, water.	



ITEM NUMBER	IV
CONTACT PERSON	Mr. Malwa (Chief Chemist)
LOCATION SYMBOL	Nairobi City Council; Kabete Water Works
DETAILS OF COMMUNICATION	From the discussions, clean water monitoring is done at the Kabete water works. The data is collected monthly and is stored in computers and laboratory files. Apart from the laboratory in Kabete, NCC also carries out water quality monitoring at Kariobangi and Ruai. This is done before and after sewage water has been subjected to treatment then it is released into the Nairobi river. On industrial effluent discharges, industries which discharge industrial effluent have an obligation of pre-treating their water before discharging it into the sewer lines because so far NCC has not yet set up a system of purifying industrial effluent.
KEYWORDS	Water quality, sewage, industrial effluent.
KEYWORDS ITEM NUMBER	Water quality, sewage, industrial effluent.
KEYWORDS ITEM NUMBER CONTACT PERSON	Water quality, sewage, industrial effluent. V Mr. Moses Otieno (Ass. Chief Engineer)
KEYWORDS ITEM NUMBER CONTACT PERSON LOCATION SYMBOL	Water quality, sewage, industrial effluent. V Mr. Moses Otieno (Ass. Chief Engineer) Nairobi City Council;Water and Sewage Department
KEYWORDS ITEM NUMBER CONTACT PERSON LOCATION SYMBOL DETAILS OF COMMUNICATION	 Water quality, sewage, industrial effluent. V Mr. Moses Otieno (Ass. Chief Engineer) Nairobi City Council;Water and Sewage Department From the discussions with Mr. Otieno, there are no policy documents of the NCC with regard to urban agriculture and waste water re-use. Several proposals have however been sent to NCC by various organisations which have an interest in waste water re-use.

6.0 TERMS OF REFERENCE AND OUTPUT

TERMS OF REFERENCE	OUTPUT
a) Water quality monitoring of rivers and surface water bodies in and around/greater Nairobi; monitoring of effluent discharges and the availability of stream flow data for rivers in and around Nairobi	10 documents have been summarised, 1 map has been identified and 2 persons have been interviewed.
 b) Studies of urban agriculture within Nairobi 	43 documents have been summarised, 2 maps have been identified and 1 person has been interviewed in this area.
c) On-going and recently completed interventions or studies conducted by multilateral and bilateral donors, national and international NGOs relevant to the control, use and development of land and water resources in the urban and peri- urban zone of Nairobi	25 documents have been summarised and 1 map identified.
d) Policy documents of Nairobi City Council that have relevance to informal urban agriculture and wastewater re-use and management now and in the future	1 person has been interviewed concerning NCC policy documents.



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