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

An Analysis of Farmer Activity and Productivity

J M Hide
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Report OD/TN 104
April 2001

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DFID Department For International Development

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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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Contract - Research

This Technical Note is an output from the Knowledge and Research Contract R7132, Improved Irrigation in Peri-Urban Areas, carried out by the Water Management Department of HR Wallingford for the British Government's Department For International Development (DFID). The research aims to improve understanding and knowledge of the productivity and hazards of peri-urban irrigated agriculture, with the objective of identifying measures to improve output whilst minimising risks to health and the e, Kenya.

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Prepared by Bridget Bosworth
(name)
RESEARCHER
(Title)

Approved by
(name)
SECTION MANAGER.
(Title)

Authorised by
(name)
Technical Director
(Title)

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Executive Summary

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This report is an output from the Department For International Development (DFID)'s Knowledge And Research Project R7132, "Improved Irrigation in Peri-Urban Areas". The research aims to identify and quantify the productivity, constraints and potential health hazards associated with informal peri-urban irrigated agriculture, with the objective of identifying practical measures to sustain and enhance the productivity of these systems.

The research is based on field studies conducted in and around Kumasi, Ghana and Nairobi, Kenya. An initial scoping survey and farmer questionnaire, reported in OD/TN 98 (Hide and Kumani, 2000), identified over 3,700 farmers irrigating 2,000 ha in 55 "clusters" within a 20 km radius of the city centre and had produced valuable data regarding the extent and nature of this sector. However, a need to provide detailed quantitative information, regarding the activities carried out and productivity, was identified. This report describes the detailed farm studies and wealth ranking exercise undertaken to address that need.

Detailed farm studies were carried out at three of the 55 clusters, located in the earlier scoping survey, for a period of four months during the dry season between June and September 2000. All three of the selected locations lie along the Nairobi River and were chosen to coincide with the water quality monitoring programme running concurrently with this work. The three locations were Thiboro, about 20 km west of the city centre, Mau Mau Bridge, about 10 km west of the city centre, and Maili Saba, which is located approximately 15km to the east of the city centre. The farmers were asked to keep a daily diary of farming activities, labour requirements, irrigation activities, expenditure and income.

The wealth ranking exercise was carried out alongside the farm studies to provide a picture of the social stratification of the communities. Its aim was to identify the positions held by farmers involved in irrigated agriculture. This work involved a literature search, field observation and community surveys.

This work shows varied approaches and objectives amongst farmers in this sector of agriculture. Some farmers clearly view it as a business and commit considerable resources in order to make a profit. One farmer at Thiboro spent over US$400 in the four-month period and made a profit of $1385. At the other end of the scale, the agricultural practices at Maili Saba are more subsistence in nature. Average profits here were just $60. Average farm profits over all six farms were $280. On an annual basis, this is equivalent to approximately $850.

Executive Summary *continued*

The wealth ranking exercise has shown that, within the three study locations, farmers tend to be comparatively better off in terms of wealth status than non-farmers. Farmers occupied the top half of positions in the wealth ranking, whilst non-farmers occupied eight of the bottom ten positions.

When labour inputs are compared across farms, there is a clear difference between those farmers cultivating intensively and those whose activities are more subsistence in nature. On an annual basis, labour hours per ha range from over 10,000 to under 2,500. On the more intensive farms, most labour was supplied by hired labour.

Irrigation is generally the most labour demanding activity, representing 66% of all labour inputs.

A wide range of crop yields was observed. One farmer had exceptional yields, such as 45 tonnes/ha of broccoli and 46 tonnes/ha of cauliflower. These very high yields are probably explained by the fact that the cropped areas are very small and very intensive cultivation was practised. Other farmers had low yields, reflecting less intensive and less skilled agricultural and irrigation practices.

Farmers sold produce either directly from the farms or in the local markets. Prices received for produce were consistent for all farmers and showed very little variation throughout the study period.

The most common method of applying water was to collect the water from the stream or river and to apply it to the crops using watering cans or buckets. Even though this is a very labour intensive method, some farmers were able to apply nearly all of the crop water requirements.

It was observed that one farmer, who occasionally used a treadle pump, was able to apply over two times more water per day, when using the treadle pump, compared to lifting and placing water using a watering can.

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1. INTRODUCTION

This report is an output from the Department For International Development (DFID)-funded Knowledge and Research Project, "Improved Irrigation in Peri-Urban Areas", carried out by HR Wallingford. The research aims to improve understanding and knowledge of the productivity and hazards of peri-urban irrigated agriculture, with the aim of identifying measures to improve output, whilst minimising risks to health and the environment. Fieldwork was conducted in Kumasi, Ghana and Nairobi, Kenya.

The work in Nairobi was divided into two phases. Phase 1 comprised a scoping survey to identify areas of significant irrigated agriculture and identify factors such as areal extent, number of farmers, water source, delivery method, land tenure and crops grown. A questionnaire survey of over 150 farmers was also carried out. This work was reported in OD/TN 98 (Hide and Kimani, 2000).

Work in Phase 2 of the project was designed to supplement and expand on the data collected in Phase 1. To this end, Phase 2 included a detailed study of six farmers in three areas of Nairobi, water quality monitoring and a wealth ranking exercise. In the detailed farm study, the farmers were asked to keep a daily diary of farming activities, labour requirements, irrigation activities, expenditure and income for a period of four months during the dry season, between June and September 2000. While these data were collected from only a small sample of farmers, the results are more detailed and are likely to be more reliable than the information derived from the Phase 1 surveys, which relied on farmer recall.

A wealth ranking exercise was carried out alongside the farm studies, to provide a picture of the social stratification of the communities, with the aim of identifying the positions held by farmers involved in irrigated agriculture. This involved a literature search, field observation and community surveys.

This report presents findings from the detailed farm studies and wealth ranking exercise. Results from the water quality monitoring study are reported separately in OD/TN 105 (Hide et al., 2001).

Chapter 2 of this report describes the three study areas and provides general descriptions of the farming systems. Chapter 3 describes the methodology used. Results of the farm studies are presented in Chapter 4 and results of the wealth ranking exercise in Chapter 5. Chapter 6 summarises the findings and presents conclusions and recommendations.

2. BACKGROUND INFORMATION AND DESCRIPTION OF STUDY AREA

2.1 Nairobi

Nairobi is located in southern Kenya, 500 kilometres from the coast, at an elevation of 1670 m. It has a population of over two million people, and covers an area of 700 square kilometres. It extends from the foothills of the Aberdares in the north, to the Ngong Hills in the south, and from the Embakasi plains in the east, up to the slopes of the Great Rift Valley wall in the west. Rainfall follows seasonal patterns, with the "long" rains falling between March and May, and "short" rains between October and December. Many farmers rely on irrigation during the driest months between June and September. The average annual rainfall is 680 mm.

2.2 Summary of findings from Phase 1

Surveys carried out in Phase 1 of this project identified over 3,700 farmers engaged in informal irrigation within a 20km radius of Nairobi city centre (Hide and Kimani, 2000). These farmers were located in 55 "clusters" and farmed over 2,000 ha between them.

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

of less than $1,000. Incomes are lower in the more urban locations, where landholdings 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 and agro-chemicals, did rank highly, despite the proximity of suppliers in and around Nairobi.

Three-quarters of the 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 stated they were squatters on government or Nairobi City Council land. The remaining 11% did not specify plot ownership; it is assumed that they are also squatters. Despite the high proportion of people having no right to the land they are farming, only one farmer stated that he had been harassed for cultivating where he did.

Over 50 different crops are grown, ranging from local subsistence crops such as maize and kale, through to exotic vegetables such as celery and Chinese cabbage. The most widely grown crops are kale, tomatoes, cabbage and spinach. Average total gross income from crops is $883 per farm. 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 formal irrigation systems.

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, farmers ranked water as being the primary constraint. Availability of inputs, lost production through crop damage, 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 to production.

2.3 Study area and general farm descriptions

Of the 55 irrigation clusters located in the scoping survey, three were selected for detailed farm studies. All three lie along the Nairobi River and were chosen to coincide with the water quality monitoring programme. These locations were at Thiboro, about 20 km west of the city centre, Mau Mau Bridge, about 10 km west of the city centre, and Maili Saba, which is located approximately 15km to the east of the city centre (figure 1).

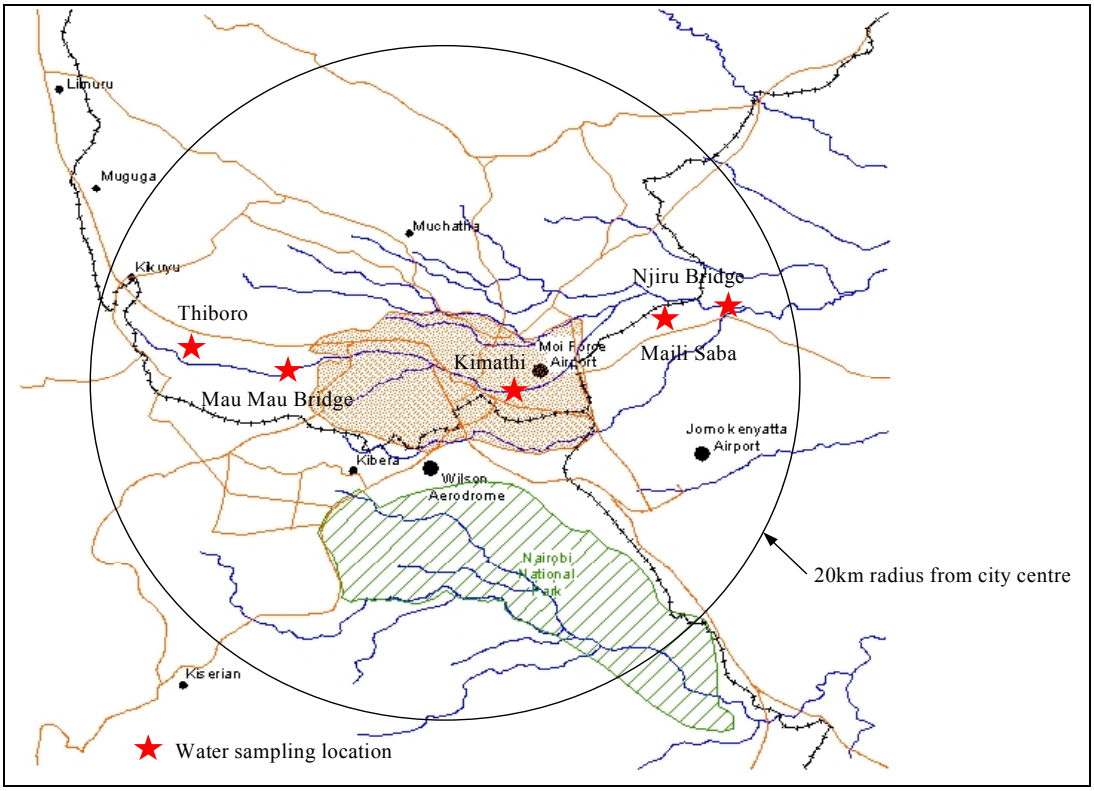

Figure 1 Location of detailed farm studies

2.3.1 Thiboro

At Thiboro, figure 2, the farm plots are situated on land sloping down to the Nairobi River, near its source. Small hand-dug wells have been constructed, and water is drawn from here and spread over the crops using buckets and watering cans. A typical plot size is 60m by 20m, and typical crops being grown include kale, cauliflower, broccoli, lettuce, cucumber, tomato, celery, pepper, sweetcorn, potato, sweet potato, carrot, onion, garlic, eggplant, and courgette. The farms are well-organised, with terracing and separation of crops. Farmers use fertilisers and insecticides when these can be afforded.

2.3.2 Mau Mau Bridge

Although Mau Mau Bridge, figure 3, is situated upstream of the main city and its industries, slums are located on the slopes above the Nairobi River at this location, and wastewater drains directly into the river. The farmers along the river have constructed small dams and weirs to raise the water level. This allows water to flow into hand constructed canals which irrigate the lower areas of the farm plots. Buckets and watering cans are used to draw water from ponds, dug at the end of the canals, to irrigate crops at higher elevations. Typical plot size and typical crops being grown are as at Thiboro. Again, the farms are well organised, with terracing and crop separation. Fertilisers and insecticides are not so widely used as at Thiboro, due to lack of funding.

Figure 2 Photograph of Thiboro

Figure 3 Photograph of Mau Mau Bridge

2.3.3 Maili Saba

At Maili Saba, figure 4, farmers have removed manhole covers and blocked the city's main sewer, causing raw sewage to rise up the manholes and flow out over the land. Hand-dug canal systems have been constructed to irrigate an estimated 100 farm plots. Farmers operate the canal system on a weekly basis, allowing flow to each farmer's plot on two specified days of the week. Farmers who do not wish to be included in this scheme must work at night.

A typical plot size is 40m by 20m, and typical crops being grown include kale, sweetcorn, potato, sweet potato, and arrowroot. No additional fertilisers are applied as the crops thrive on the nutrients present in the raw sewage. These crops do not suffer from blight like the farms at Thiboro and Mau Mau Bridge. The farms are not terraced, and crops are mixed together in a random fashion. Farmers have invested

considerable time and effort in terracing the land, despite the fact that they are squatting on government or city council land.

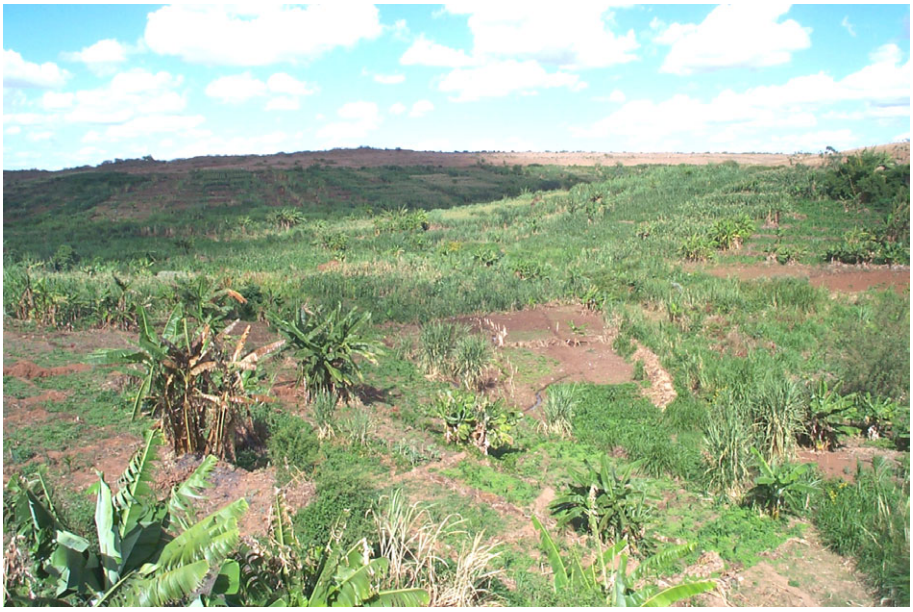

Figure 4 Photograph of Maili Saba

3. STUDY METHODOLOGY

3.1 Farm studies

Site selection was completed in late May 2000 and data were then collected over the main irrigation period from June 2000 to September 2000. Due to budget constraints, it was only possible to include two farmers, selected at random, from each of the three areas. Two of the farmers, one at Thiboro and one at Maili Saba, were women. It is acknowledged that, with data from only six farms, it is not possible to calculate averages that would be representative of activities over the whole Nairobi peri-urban irrigated agriculture sector. Nevertheless, the data provide a valuable insight into the activities and productivity of this sector.

A field survey was conducted with each farmer to determine the land area under each irrigated crop. Photographs of the plots were also taken once a month in order to illustrate changes in cropping. Each farmer was provided with a diary to record farming activities and farm budget information covering farm activities, labour, agronomic inputs, irrigation water application, equipment use and marketing. The complete range of data collected is shown below.

General information:

- Cropping – crops, cropped areas, reasons for growing
- Credit – source, loan amount, date of loan, repayment information
- Equipment – items, quantity, year purchased, cost new

Daily records:

- Agronomic inputs – type, brand, crop, quantity, cost
- Labour – type, activity, crop, time, payment
- Irrigation – crop, area, volume applied
- Equipment hire – type, number, cost

- Marketing – date, crop, market, quantity sold, unit price, marketing costs
- Other remarks

A regular, weekly visit was made to each farmer to ensure that the data was being accurately recorded. This was continued throughout the four-month period of the study. The farmers were not paid during the course of the work, but were given a small payment at the conclusion of the four-month data collection period.

Data analysis has been carried out on a financial rather than an *economic* basis. Opportunity costs of labour have not been included, nor have labour hours been converted to standard hours according to age or gender. The analysis thus provides information relevant to the household, i.e. the actual profit or loss made.

3.2 Wealth ranking exercise

3.2.1 Objectives

The overall objective for wealth ranking was to generate information on the comparative position of irrigating farmers within the wider community – whether they were below average, average or above average, in terms of income. It would also include examining whether farmers' standard of living has changed since they started irrigating. A limited field survey focused on the three communities in which the farmers participating in the detailed farm surveys lived. Details of the methods used in the wealth ranking study are given in Appendix A.

4. RESULTS FROM FARM STUDIES

4.1 Plot sizes and crop choice

The average plot size for the six farms studied is 0.08ha (0.2 acre) and ranges from 0.03ha to 0.14ha (0.1 acre to 0.35 acre), see table 1. These areas are generally smaller than 0.6ha, the average irrigated area identified during the Phase 1 surveys (Hide and Kimani, 2000). Actual plot measurements were taken in the detailed studies, whilst farmers were only asked to estimate their plot areas in the earlier work.

In total, 22 crops were grown. These included local "subsistence" crops such as maize and kale, and also "exotic" market vegetables such as Chinese cabbage and lettuce. Table 1 identifies the crops grown by each farmer and the individual crop areas. In general, the more exotic crops are grown in Thiboro and subsistence crops in Maili Saba. The most widely grown crop was kale, both in terms of number of farmers and cultivated area. The next most common crops, in terms of area, are capsicum and maize. The results from the wider Phase 1 survey also indicated that kale was the most common crop, in this case followed by tomatoes, cabbage and spinach.

Each farmer grew an average of 7 crops each on an average of 0.01ha (0.027 acre). However, most farmers seem to concentrate on one or two main crops, i.e. farmer 001 concentrates on capsicum, farmer 002 on cauliflower and celery, farmer 003 on kale, farmer 004 on kale and maize, farmer 005 on amaranths and kale, and farmer 006 on maize.

Table 1 Crop selection and cropped areas (ha)

Crop	Thiboro 001	Thiboro 002	Farm Mau Mau Bridge 003	Mau Mau Bridge 004	Maili Saba 005	Maili Saba 006
Amaranths					0.010	0.007
Arrowroots				0.002	0.003	0.010
Beans						0.003
Broccoli	0.011	0.012				
Bulb Onions			0.003	0.001		
Cabbage	0.004					
Capsicum	0.064		0.001	0.001		
Cauliflower		0.047				
Celery		0.023				
Chinese Cabbage		0.019				
Courgettes			0.001			
Cowpeas				0.014		0.003
Cucumber		0.019	0.001			
Fennel herb		0.002				
Kales		0.006	0.030	0.034	0.010	0.010
Lettuce	0.030					
Maize				0.017	0.005	0.024
Potatoes			0.001			
Spinach		0.014	0.001	0.011		
Sugarcane					0.003	0.003
Sweet Potatoes			0.001		0.002	0.007
Tomatoes			0.004	0.011		
Total	0.109	0.143	0.041	0.088	0.032	0.069

4.2 Costs, revenue and profit

Records were kept on farm expenditure under the headings of equipment purchase and hire, agronomic inputs, labour and marketing (both costs and revenues from sales). Table 2 and figure 5 show total expenditures and revenues, along with total farm profits, for the six farms.

Table 2 Farm costs, revenues and profits (US$)

Farm	Area	Costs							Revenue	Profit	Profit per ha
		Seeds	Manure	Fertiliser	Fungicide	Pesticide	Labour	TOTAL			
001	0.109	31	48	7	10	2	139	237	232	-4	-37
002	0.143	3	66	66	9	47	227	417	1802	1385	9685
003	0.041	4	13	12	29	1	0	60	68	8	195
004	0.088	2	24	6	1	0	0	33	196	162	1841
005	0.032	1	0	0	0	0	0	1	63	62	1940
006	0.069	0	0	0	0	0	0	0	60	60	870

Note: Exchange rate used is US$1 = KSh78.8

There is a very wide range of farm profits. Farmer 001 made a loss of $4 whilst his neighbour, farmer 002, made a profit of nearly $1400. There is also a wide variation in expenditures and revenues. Farmers 001 and 002 had expenditures of $237 and $417, respectively, with labour costs comprising the largest component. Manure was the second largest expense for farmer 001, whereas both manure and fertiliser

formed the second largest expense for farmer 002. Farmers 003 and 004 had considerably lower outlays of $60 and $33, respectively. For farmer 003, fungicide was the largest expense, and for farmer 004, it was manure. The two farmers at Maili Saba had expenditures of zero or $1 only. The pattern of expenditures reflects the general impression gained of the quality and intensity of farming at each of the three locations. Expenditure per ha is about $2500 at Thiboro, $920 at Mau Mau Bridge and virtually zero at Maili Saba. Farming at Thiboro is clearly regarded as a business, whilst at Maili Saba it provides household food and a small income from any surplus produce.

Farmer 001 made an unexpected loss of $4 and farmer 003 made only a small profit of $8. Farmer 001 concentrated on capsicum production, with over half the cultivated area devoted to this crop. Unfortunately, he experienced problems of fungal attack on the plants, apparently a common problem in the area, despite spending $10 on fungicide. As a result, only a small profit of $5 was made on this crop. This farmer appeared to make a loss of $21 on lettuce. The lettuce beds were planted during the study period and it is assumed that further sales of both lettuce and capsicum may well have improved the bottom line results for these crops.

Farmer 003's modest profit is probably explained by the fact that he started cultivation shortly before the start of this study and was therefore spending money on crops that were not harvested and sold during the study period.

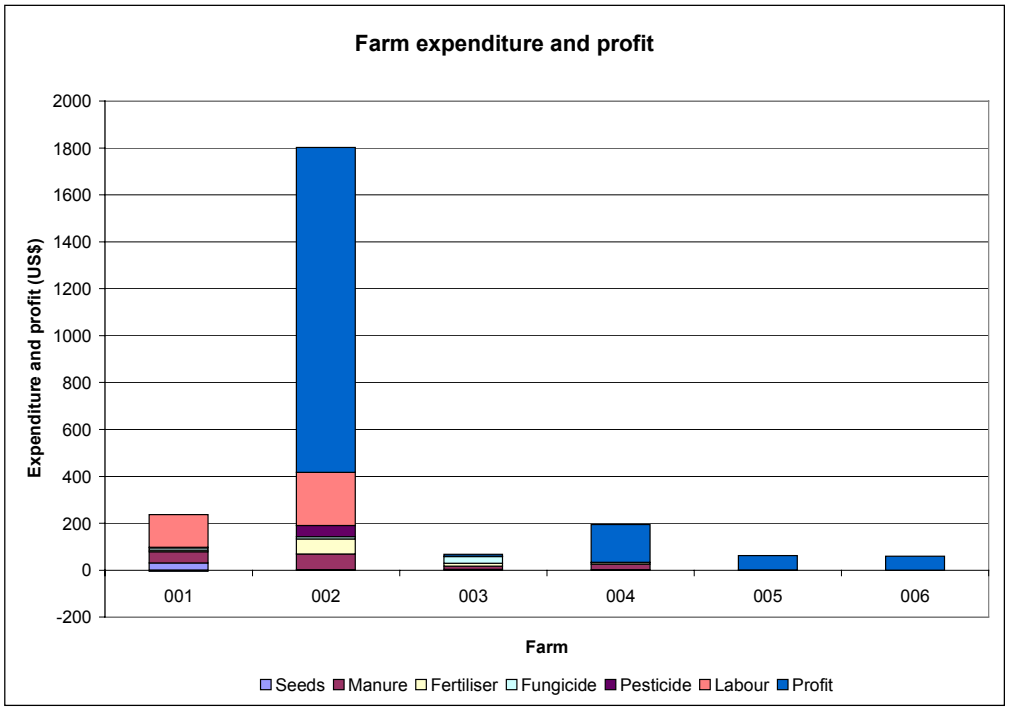

Figure 5 Crop expenditure and profit

4.3 Labour

Labour inputs assigned to various activities were recorded each day. Table 3 and figure 6 summarise the results for each farm as follows: labour inputs for each activity, total labour, total labour per ha and who carried out the tasks.

Table 3 Labour allocation (hours)

Activity	Thiboro 001	Thiboro 002	Farm Mau Mau Bridge 003	Mau Mau Bridge 004	Maili Saba 005	Maili Saba 006
Planting	36	69	24	21	6	7
Manuring	30	35	9	10	0	0
Spraying	20	116	11	15	0	0
Weeding	292	84	40	52	86	61
Irrigation	418	832	264	328	60	67
Total	796	1135	348	426	152	135
Total per ha	2970	3225	3439	1952	1900	794
Self	-	-	47%	53%	100%	100%
Wife/husband	-	-	44%	39%	-	-
Children	-	-	9%	-	-	-
Paid labour	100%	100%	-	8%	-	-

Note: Labour inputs for land preparation was recorded as the area was prepared. Labour for harvesting was not recorded.

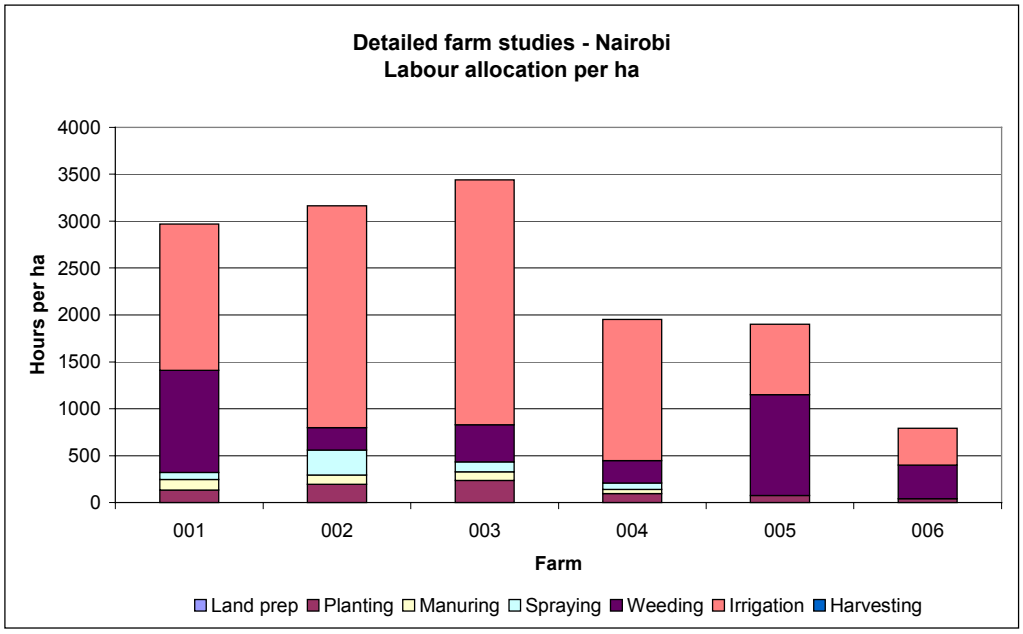

Figure 6 Labour input per ha

It can be seen that, as for other inputs, there is nearly a ten-fold difference between the most and least labour intensive farms, ranging from a total of 1135 hours on farm 002 to just 135 hours on farm 006, or 9.5 hours and 1.1 hours/day, respectively. There is also a similarly marked difference in labour hours per ha. Nearly 3500 hours/ha are expended by farmer 003 and his wife and children, who have just started production and are experimenting with various crops and techniques (figure 6). Farms 001 and 002, where the labour is carried out wholly by paid labourers, have similar levels of labour input, at 2970 and 3225 hours per ha, respectively. Farms 004 and 005 have lower levels of labour, at around 1900 hours per ha, whilst farm 006 is significantly lower, at under 800 hours per ha, again reflecting the low intensity of the farming that is generally observed at Maili Saba.

Irrigation represents the most labour intensive activity on all farms, except farm 005, where weeding is the most labour intensive activity. Irrigation represents from between 39% of labour inputs, on farm 005, to 77%, on farm 004. In general, weeding is the next most onerous activity. The application of manure and agro-chemicals is not carried out at Maili Saba, where raw sewage is used for irrigation.

Labourers (two or three per farm) were employed to carry out all activities on farms 001 and 002. Wage rates on the two farms were consistent at an average of $0.17 per hour on farm 001, and $0.2 per hour on farm 002. Labour costs on these two farms equates to about $1400 per ha and is the biggest investment of all inputs.

4.4 Crop yields and marketing

Farmers were asked to record all sales of produce by noting quantities sold along with the unit and total price received. Any marketing costs, such as transport, were also shown. From this data, it is possible to calculate crop yields per ha. Crops were usually sold in kilograms or "bundles". A standard figure of 0.25kg/bundle was used to convert values to kilograms and the unit price checked with standard market rates to ensure that the resulting kilogram yields were correct. Table 4 shows the yields achieved on all six farms in tonnes/ha. The figures for the two farms at Maili Saba may not be representative, as analysis of the unit prices seems to indicate that the crops were not sold in the "standard" sized bundles.

Table 4 Crop yields (tonnes/ha)

Crop	Thiboro 001	Thiboro 002	Mau Mau Bridge 003	Mau Mau Bridge 004	Maili Saba 005	Maili Saba 006
Amaranthus					1.8	2.8
Arrowroots				no sales	8.0	3.8
Beans						no sales
Broccoli	0.9	45.6				
Bulb Onions			no sales	no sales		
Cabbage	6.3					
Capsicum	9.2		no sales	no sales		
Cauliflower		46.3				
Celery		13.7				
Chinese Cabbage		26.1				
Courgettes			no sales			
Cowpeas				1.2		0.3
Cucumber		48.7	no sales			
Fennel herb		179.7				
Kale		30.5	6.3	9.1	5.8	4.0
Lettuce	0.8					
Maize				no sales	8.0	1.3
Potatoes			no sales			
Spinach		52.1	53.2	29.6		
Sugarcane					0.6	no sales
Sweet Potatoes			no sales		no sales	no sales
Tomatoes			5.6	13.3		

Note: These data only represent crops sold and do not account for any produce used by the farm household. Also, cultivation in Nairobi is a year-round activity and thus the figures above may relate to more or less than one crop cycle.

The first striking feature of the data are the high yields obtained on farm 002. Discounting the 180 tonnes/ha of fennel as unrealistic, yields of over 40 tonnes/ha were obtained for broccoli, cauliflower and spinach. As a comparison, the Agricultural Compendium for Rural Development in the Tropics (EUROCONSULT, 1989) suggests yields of 20 tonnes/ha for cauliflower and 15 tonnes/ha for spinach under improved agricultural practices. The question is therefore whether the data is suspect or whether the yields were as high as calculated. If the yields are as shown, this may be because the crop areas are all very small, i.e. 0.012ha for broccoli, 0.047ha for cauliflower and 0.014ha for spinach. With the intensive cultivation practices adopted on this farm, it may well be possible to achieve these yields. The high spinach yields on farms 003 and 004 would also support this supposition. If this is the case, however, it is probably not possible to replicate this performance on larger farms.

The yields for the other crops are within the expected bounds, with a few exceptions where yields are very low. As stated above, this is probably due to a proportion of the crop being taken for home consumption

and therefore not recorded, or because the crop did not reach the harvesting stage during the period of study.

Farmers utilised two outlets for marketing produce: local markets or direct sales from the farm. Analysis of unit prices shows very little difference in the prices received, with differences in the order of ±10%.

4.5 Irrigation management

The farmers at Thiboro applied water manually using watering cans or buckets. Water was collected in shallow dug-outs that filled with seepage water from the small stream at the bottom of the valley or from the hillside. A few farmers in this area used sprinklers connected to city council water taps. Farmers at Mau Mau Bridge are located along the banks of the Nairobi River and take their water from here. A couple of farmers used petrol pumps but the majority lift and place the water manually, using buckets and watering cans. A few farmers have dug shallow wells to collect the water in a more convenient place. One or two farmers also constructed temporary weirs across the river to raise the water level in order to reduce the amount of lifting required. One of the farmers studied, farmer 003, borrowed a treadle pump on a few occasions during the study. Water was lifted from a dug-out and applied directly to the crops through a flexible hose.

The situation is quite different at Maili Saba. Here the farmers are utilising raw sewage water that is obtained from broken sewer lines. Figure 7 shows a manhole on one of the main sewer lines that has been blocked by farmers. The sewage rises up the manhole and is then allowed to flow along contour canals that have been constructed along the upper edge of the irrigated area. At the field level, the sewage water is allowed to flood the cropped area, on some farms in a fairly chaotic manner, on others by more controlled application along short furrows. The health implications of such practices are discussed in another paper (Hide et al., 2001). In the bottom of the valley at Maili Saba, the land is fairly waterlogged and it is expected that the majority of crop water requirements are satisfied from this source, although farmers sometimes use buckets to manually water plants.

Figure 7 Broken manhole at Maili Saba

All the farmers were asked to record details of their irrigation activities. From this information, it is possible to calculate the volumes and depths of water applied to individual crops (table 5 and figure 8). Volumes of water applied from the gravity channels at Maili Saba have been estimated using a conservative flow of 2 l/s.

Table 5 Irrigation volumes and depth applied (m^3 and mm/day)

	Farm					
	Thiboro 001	**Thiboro 002**	**Mau Mau Bridge 003**	**Mau Mau Bridge 004**	**Maili Saba 005**	**Maili Saba 006**
Method	Watering can	Watering can	Watering can/treadle	Watering can	Gravity – flood/bucket	Gravity – flood/bucket
Volume applied (m^3)	65	588	130	230	319	306
Depth applied (mm/day)	0.5	3.4	2.6	2.2	8.3	3.7

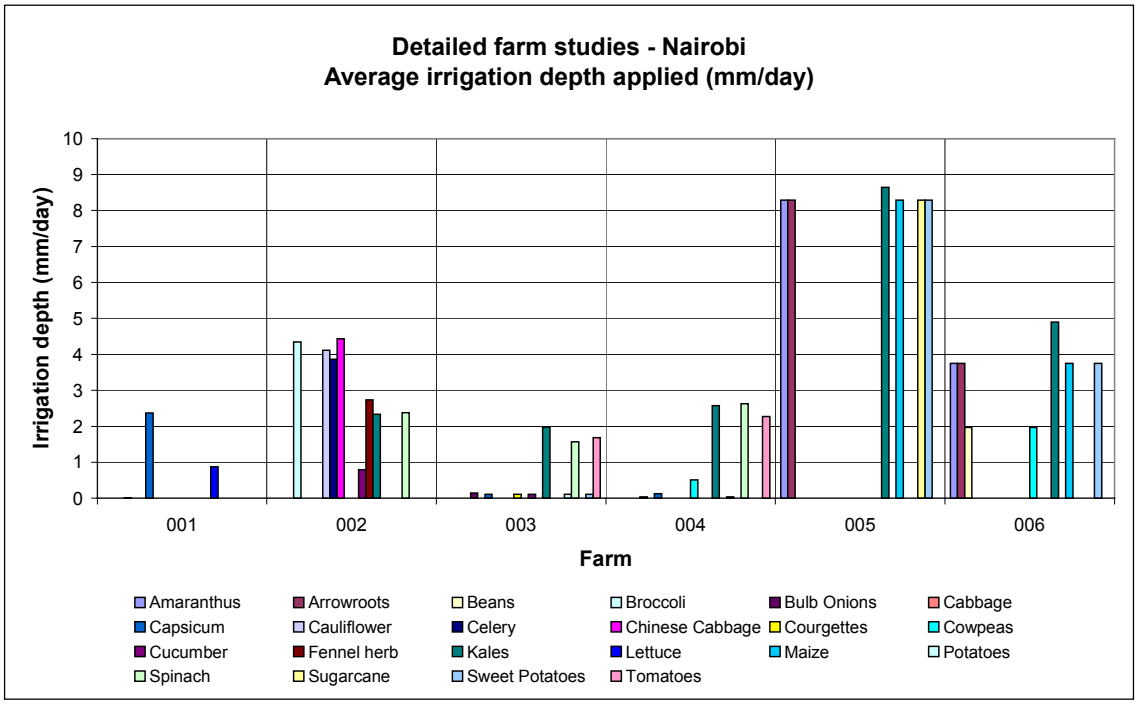

Figure 8 Irrigation depths applied

The greatest depths of water are applied on farms 005 and 006, with averages of 8.3 and 3.7 mm/day, respectively. This is not surprising since only a small proportion of the water is lifted manually. Of the other farms, where all water is applied manually, farmer 002 applies the most, with an average depth of 3.4 mm/day. This was achieved by filling, carrying and emptying over 300 watering cans per day and explains why irrigation is the most labour intensive activity. Smaller amounts were applied at the other farms.

Farmer 003 occasionally used a treadle pump to apply water. On the days the treadle pump was used, an average of 6.9mm was applied, compared to 3.2mm when using watering cans. This represents an increase of 115%.

Comparison with calculated crop water requirements shows that the average daily crop water requirement during the study period, Nairobi's winter, is approximately 3 to 4 mm/day. A substantial proportion of the crops' needs was therefore met by the applications calculated above.

In all cases, except farm 005 where crops are intermingled seemingly haphazardly, differing depths of water are applied to different crops.

5. RESULTS FROM WEALTH RANKING EXERCISE

The results are presented in more detail in appendix A.

5.1 General information

In each of the study sites, the village was used as the basis for defining a sampling frame. This was because intra-community relations (building of school, church or arbitration of local disputes) are conducted at the village level. For each site, a sample of 10 respondents was selected, consisting of farmers and non-farmers, as shown in table 6.

Table 6 Breakdown of respondents

Location	Farmers	Non-farmers	Total
Thiboro	7	3	10
Mau-Mau Bridge	7	3	10
Maili Saba	5	5	10
Total	19	11	30

Originally, the plan was to reflect three categories of respondents, i.e. rain-fed farmers, irrigation farmers and non-farmers. In reality, at Thiboro and Mau Mau Bridge, nearly all farmers engaged in both irrigated and rainfed agriculture, and this is why farmer respondents are over-represented in the samples at these two sites.

A summary of general information of respondents is given in table 7.

Table 7 Gender and age of respondents

Location	Gender		Age (years)		
	Male (%)	Female (%)	Mean	Minimum	Maximum
Thiboro	70%	30%	37	23	71
Mau Mau Bridge	60%	40%	38	30	47
Maili Saba	30%	70%	36	24	86
TOTAL	53%	47%	37	23	86

The education levels of the respondents varies. 6% had no formal education and 4% had post-secondary/tertiary training. 50 % had secondary level education, while 40% had gone up to primary level.

Farming was the main occupation for 63% of interviewees, while the remaining 37%, who were not farmers, carried out various activities, ranging from hawking to cottage activities such as shoe repair and dressmaking.

5.2 Wealth indicators and wealth ranking

5.2.1 Income levels

The average household income (farm and non-farm income) of all farmers was approximately US$2900[1], whilst that of non-farmers was $686. Details of income for both farmers and non-farmers are given in table 8. Table 8 also shows that there were large differences between the three locations.

Table 8 Annual household income from farm and non-farm activities

Location	Farm income per annum (US$)			Non-farm income per annum (US$)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Farmers						
Thiboro	2047	660	5428	2696	0	15000
Mau Mau Bridge	1076	731	1472	998	127	3046
Maili Saba	523	178	977	621	0	1218
All farmers	**1216**	**178**	**977**	**1692**	**0**	**15000**
Non-farmers						
Thiboro	-	-	-	668	259	1066
Mau Mau Bridge	-	-	-	503	381	609
Maili Saba	-	-	-	888	259	2627
All non-farmers	**-**	**-**	**-**	**686**	**259**	**2627**

[1] One farmer had a very large non-farm income of $15,000. Removing this farmer from the calculation, the average household income for the remaining respondents was approximately $2400. Exchange rate used is US$1 = KSh78.8

The farm income figures relate to those found in the detailed farm studies. Averaging the profits of the farms at each location, and assuming similar performance throughout the year, yields annual farm profits of $2078 at Thiboro, $486 at Mau Mau Bridge[2] and $183 at Maili Saba, with an overall average of $549. The differences between the two data sets can probably be explained by the addition of other non-irrigated agriculture income included in the wealth ranking figures.

5.2.2 Wealth ranking of the communities

The 30 respondents were ranked using the wealth ranking scoring system described in Annex 1. Table 9 gives the wealth score for each respondent, and identifies the location and whether the person is a farmer or not.

Table 9 Wealth ranking scores

Rank	Location	Farmer/non-farmer	Wealth score	Rank	Location	Farmer/non-farmer	Wealth score
1	Thiboro	Farmer	317	16	Thiboro	Farmer	82
2	Thiboro	Farmer	235	17	Maili Saba	Non-farmer	77
3	Mau Mau Bridge	Farmer	212	18	Maili Saba	Farmer	75
4	Thiboro	Farmer	192	19	Thiboro	Non-farmer	75
5	Thiboro	Farmer	158	20	Mau Mau Bridge	Farmer	72
6	Mau Mau Bridge	Farmer	128				
7	Mau Mau Bridge	Farmer	114	21	Mau Mau Bridge	Non-farmer	71
8	Thiboro	Farmer	112	22	Mau Mau Bridge	Non-farmer	69
9	Mau Mau Bridge	Farmer	98	23	Maili Saba	Farmer	58
10	Mau Mau Bridge	Farmer	94	24	Maili Saba	Non-farmer	53
				25	Mau Mau Bridge	Non-farmer	52
11	Thiboro	Farmer	89	26	Maili Saba	Non-farmer	48
12	Maili Saba	Farmer	88	27	Thiboro	Non-farmer	48
13	Mau Mau Bridge	Farmer	87	28	Maili Saba	Non-farmer	47
14	Maili Saba	Farmer	86	29	Maili Saba	Farmer	44
15	Thiboro	Non-farmer	83	30	Maili Saba	Non-farmer	41

5.2.3 General remarks

Farmers within the study sites appear to be comparatively better off in terms of wealth status than non-farmers. This is particularly so in Maili Saba where community members have a choice of either engaging in irrigated farming or pursuing other economic activities. Those who practice irrigated farming generally surpass non-farmers in wealth ranking. Non-farm incomes of farmers also surpass those of non-farmers.

For those who practise irrigation, experience does seem to be advantageous, since six of the top ten positions in the wealth ranking are occupied by farmers who have ten or more years' irrigation experience.

6. SUMMARY OF PRINCIPAL FINDINGS AND CONCLUSIONS

The detailed farm studies and wealth ranking exercise have provided valuable information regarding the practices and productivity of informal peri-urban farmers and fill in many gaps highlighted during the Phase 1 scoping survey and questionnaire survey.

6.1 Farm incomes

It is clear that there is a wide variety of approaches and objectives in this sector of agriculture. Some farmers clearly view irrigated production as a business and commit considerable resources in order to make a profit. For example, farmer 002 spent over $400 during the four-month period on inputs and labour. This equates to well over $1000 per year. Even so, he made a profit of $1385 and over a year, he

[2] Farmer 003 is discounted from this calculation since he had only just started production.

may be expected to make a profit of over $4000. Unfortunately, his neighbour (farmer 001) had problems with his capsicum crop and as a result suffered a financial loss.

At the other end of the scale, the agricultural practices at Maili Saba are more subsistence in nature. Fewer exotic market vegetables are grown and very little inputs are applied. Labour inputs are also low. Farm profits were about $60 during the study, equating to about $200 over a year. The farmers here are squatting on government land and, as such, may be reluctant to invest heavily in activities in developing land from which they may be removed at any time. In addition, they will have had little formal access to agricultural extension services. Although the water they use will have high concentrations of organic matter and should assist crop growth, observed yields are low. Field layout and overall agronomic practices are very basic.

Average farm profits over all six farms amounted to $280. On an annual basis, this is equivalent to approximately $850. This is less than the annual household income of $1700 (at 1999 exchange rates) observed during Phase 1. However, this higher figure was based on an estimate for the total income from the respondents.

6.2 Wealth ranking

The wealth ranking exercise has shown that, within the three study locations, farmers tend to be comparatively better off in terms of wealth status than non-farmers. Farmers occupied the top half of positions in the wealth ranking, whilst non-farmers occupied eight of the bottom ten positions. With reference to individual sites, in Thiboro, farmers take the first six positions out of ten, in Mau Mau Bridge, they take the first seven positions and in Maili Saba, they take the first two positions.

Clearly, farmers have income from farming activities that non-farmers lack, but they also tend to have larger non-farm incomes than non-farmers (except at Maili Saba). Across all sites, average total annual income for farmers was $2908 and for non-farmers, it was $686.

6.3 Labour

When labour inputs are compared across farms, there is a clear difference between those farmers cultivating intensively and those whose activities are more subsistence in nature. On an annual basis, labour hours per ha range from over 10,000 to under 2,500. On the more intensive farms, most labour was supplied by hired labour.

Irrigation is generally the most labour demanding activity, representing 66% of all labour inputs. Despite this, or perhaps because of this, farmers were able to apply nearly all the crop water requirements. As an activity, irrigation is particularly onerous when water is applied manually.

6.4 Crop yields and marketing

A wide range of crop yields was observed. One farmer had exceptional yields, such as 45 tonnes/ha of broccoli and 46 tonnes/ha of cauliflower. These very high yields are probably due to the fact that the cropped areas are very small and very intensive cultivation was practised. Other farmers had low yields, reflecting less intensive and skilled agricultural and irrigation practices.

Farmers sold produce either directly from the farms or in the local markets. Prices received for produce were consistent for all farmers and showed very little variation throughout the study period. Farmers can therefore be fairly certain of prices, and hence revenue, and can plan their expenditure accordingly.

6.5 Irrigation management

The most common method of applying water was to collect it from the stream or river, and to apply it to the crops using watering cans or buckets. Even though this is a very labour intensive method, some

farmers were able to apply nearly all of the crop water requirements of about 3 or 4 mm/day. For example, farmer 002 applied an average of 3.4 mm/day during the study period.

It was observed that one farmer, who occasionally used a treadle pump, was able to apply over two times more water per day, when using the treadle pump, compared to lifting and placing water using a watering can.

The greatest concern at Maili Saba is the use of raw sewage water for irrigation. Full results of the water quality programme are contained in another report (OD TN 105) (Hide et al., 2001). However, faecal coliform counts were in excess of 10^7 FC/100ml in samples taken at Maili Saba. WHO recommended limits for unrestricted irrigation are 10^3 FC/100ml (Mara and Cairncross, 1989). It is therefore likely that the health of several groups of people are put at risk through contact with the water, including the farmers and their families, and potentially the wider public who purchase crops from this location.

7. ACKNOWLEDGEMENTS

Fieldwork for the detailed farm studies was carried out by Joseph Kimani Thuo and the wealth ranking study by John Kimani of Rural Development Services. Their large contribution to the study is gratefully acknowledged.

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Appendix A

Wealth Ranking Survey of Communities in the Peri-Urban Farming Zones of Nairobi Report

by Rural Development Services
(Agricultural Consultants)

for HR Wallingford
September 2000

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Tables

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1. INTRODUCTION

1.1 Study Background

Peri-urban agriculture is understood to be the agricultural activities undertaken within the area immediately surrounding the city, where the presence of the city has an impact on land values, land use, property rights, and where proximity to the urban market and the urban demand drive changes in agricultural production.

Urban agriculture is one of several strategies used by urban dwellers to cope with poverty. It is mainly carried out by, but not restricted to, the urban poor in their efforts to meet the food needs of their households. The sale of produce is an integral part of the food production, and acts as a source of cash without cutting into the household's food supply. Revenue accruing from sale of produce is used for various purposes, such as purchase of household requirements, education of children and health expenses.

The Phase I study, carried out in Nairobi earlier in the year, shows that irrigated agriculture constitutes an important income source for many peri-urban dwellers. Indeed, the study estimates that in Nairobi, over 3,700 peri-urban residents are involved in agricultural production. Equally significant is the finding that, for 86% of the surveyed peri-urban farmers, irrigated agriculture provides the main source of income. There was therefore a need to establish the economic status of irrigating farmers in relation to other members of the local community.

1.2 Study Objectives

The study terms of reference covered three main objectives:

(a) To determine the wealth distribution of the communities in which the farmers studied in the farm diary surveys live

(b) To identify the relative position of farmers involved in dryland (rainfed) and irrigated farming within this distribution

(c) To prepare a short report detailing the findings of the study and give recommendations for maximising the impact of improvements in irrigated farming on the livelihoods of the poorest.

1.3 Expected Outputs

The study was expected to generate information that shed light on the comparative position of irrigating farmers within the wider community – whether they were below average, average or above average in terms of economic welfare. It would also include examining whether farmers' standard of living has changed since they started irrigating.

2 STUDY METHODOLOGY

2.1 Overview of Relevant Literature

Several studies have been conducted on urban agriculture in the peri-urban areas of Nairobi.

The Mazingira Institute has published papers on studies, conducted in 1984, 1985 and 1994, on farming activities in Pumwani, Eastleigh and Korogocho. The main findings were that 20% of study area households were actually growing crops. Dennery (1996) examined farming activities in the Kibera area and observed that there are relatively few organised groups of producers. HR Wallingford has completed Phase 1 of a comprehensive study on peri-urban irrigated agriculture in Nairobi (Hide and Kimani, 2000). Some of the Phase 1 findings are:

- Approximately 3700 farmers are engaged in irrigated farming within a radius of 20 kms of the city centre
- Irrigation is relatively new and 49 % of the farmers have been irrigating for less than 5 years

- For approximately 86% of the farmers, irrigation is the main source of the household income.

In all the studies, there is unanimous consensus about the importance of peri-urban farming as a source of food, income and employment (Lee Smith, 1988; Freeman, 1991; Dennery 1995; Hide and Kimani, 2000).

2.2 "Wealth": - a Definition

The term "wealth" is rather elastic and is usually culture specific. Within a given community, however, there is general consensus of who is perceived as "wealthy" or "poor". Conventional economics assumes "gross domestic product (income)" per capita as a valid yardstick for comparing the wealth of nations.

United Nations Development Programme, on the other hand, has developed the "Human Development Index" as a composite measure of relative wellbeing among nations of the world. In calculating the index, a range of indicators (access to food, water, health, etc) is used.

For this study, wealth of a household was defined as the sum total of its tangible capital assets (land, dwelling, furniture, motor vehicle, etc), financial resources (money in bank and income from any source) as well as other worldly possessions that have exchange value.

2.3 Wealth Indicators

During participatory rural appraisal (PRA) sessions conducted in the Baringo District of Kenya, local communities were facilitated to develop a set of attributes upon which household wealth ranking was based. With appropriate modification, a similar approach was used in analysing wealth comparisons in the three study sites.

A range of attributes that signify household wealth status were identified and incorporated into a survey questionnaire. These included the level of farm and non-farm income, level of household expenditure, type and quantity of durable consumer goods, type of house building material, etc.

A subjective scoring frame was defined, where weights were assigned to different attributes. For instance, possession of a capital-intensive item such as a car attracted a higher weight score than a bicycle. Similarly, a house whose walls are constructed from stone scored higher than one made of iron sheets. While the method could be refined further, in its present form it allows disparate wealth indicators to be compared and added. An aggregate score, summing the total scores of the surveyed household, was calculated, permitting a wealth ranking exercise to be conducted. More details regarding scoring scale for different wealth attributes are given in table 13.

2.4 Field Work

2.4.1 Field Survey Methods

In each of the study sites, the village was used as the basis for defining a sampling frame. The village was used because intra-community relations (building of school, church or arbitration of local disputes) are conducted at the village level. For each site, a sample of 10 respondents was selected consisting of farmers and non-farmers, as shown in table 1 below.

Table 1 Sample of farmers and non-farmers

Study Site	Farmers	Non-farmers	Total
Thiboro	7	3	10
Mau-Mau Bridge	7	3	10
Maili Saba	5	5	10
Total	19	11	30

Originally, the plan was to reflect three categories of respondents, i.e. rainfed farmers, irrigation farmers and non-farmers. In reality, in Thiboro and Mau-Mau Bridge, nearly all farmers are simultaneously engaged in both irrigated and rainfed agriculture, which is why farmer respondents are over-represented in the samples at the two sites.

A semi-structured questionnaire was administered to the 30 respondents. Additional information was obtained through discussions with key informants, field observations and photography.

3 FINDINGS AND DISCUSSION

3.1 General Observations on the Study Area

The study was carried out in three sites in which the farmers maintaining farm diaries lived, i.e. Thiboro, Mau Mau Bridge, in Westlands division, and Maili Saba, in Embakasi division. An overview of the three study sites is presented in table 2 below. Thiboro and Mau Mau Bridge farmers extract their irrigation water from Nairobi River and its tributaries. Maili Saba farmers extract water from a sewer line that passes through the area.

Table 2 Summary of General Observations on the Study Sites

Observation Items	Study Site		
	Thiboro	Mau-Mau Bridge	Maili Saba
1. Land tenure status	-Farmers own land -Non-farmers rent houses	(as Thiboro)	-Farmland leased from private owner -House erected on city council land on a squatter basis
2. General land layout and land use	-Sloppy, with high ground used for rainfed cultivation and bottom land irrigated for horticultural production -Houses erected on upper portion for owner use and for renting to non-farmers	(as Thiboro)	-Mix of flat and sloppy land -Irrigated land separate from housing land
3. Source of Irrigation water	-Permanent stream running along the valley bottom	(as Thiboro)	-Main sewage drain
5. Cropping pattern	-Intensive commercialised horticulture featuring high value crops	(as Thiboro)	-Mixed cropping of food and low value horticultural crops for home use and sale

3.2 General Information of Respondents

A summary of general information of respondents is given in table 3.

Table 3 Gender and age of respondents

	Gender				**Age**		
	Males	(%)	Females	(%)	Mean	Minimum	Maximum
Thiboro	7	70%	3	30%	37	23	71
Mau Mau Bridge	6	60%	4	40%	38	30	47
Maili Saba	3	30	7	70%	36	24	86
ALL	**16**	**53%**	**14**	**47%**	**37**	**23**	**86**

The education levels of the respondents varied - 6% had no formal education and 4% having had post-secondary/tertiary training. 50 % had secondary level education, while 40% had gone up to primary level (see annex 1 for details on questionnaire results).

60% of interviewees said farming was their main occupation, while 40% were non-farmers and carried out various activities, ranging from hawking to cottage activities, such as shoe repair and dressmaking. There was a case of a farmer who said farming was a second occupation.

For the farmers, 0.71 ha was the average land under cultivation. However, there was a wide difference between the minimum and maximum land under cultivation – 0.10 and 7.1 ha, respectively. The mean area under irrigation was lower, at 0.41 ha. The area under irrigation ranged from a minimum of 0.05 to a maximum of 2.5 ha.

The average number of years that farmers have been practising irrigation is 8.3 years. This ranges from a minimum of 1 year to a maximum of 30 years.

3.3 Wealth Indicators and Wealth Ranking

3.3.1 Income Level of Farmers

The income of farmers from the three study sites is shown in table 4 below. (At the time of the surveys, the exchange rate was US$1 = KSh78.8).

Table 4 Annual income of farmers from farm and non-farm activities per annum

	Farm Income per Annum (Ksh)			*Non-Farm Income per Annum* (Ksh)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Thiboro	161,328	52,000	427,700	212,428	0	1,182,000
Mau Mau Bridge	84,800	57,600	116,000	78,628	10,000	240,000
Maili Saba	41,220	14,000	77,000	48,960	0	96,000
ALL	95,782	14,000	247,700	133,338	0	1,182,000

3.3.2 Income of Non-farmers

Table 5 below summarises the non-farmers' income.

Table 5 Income of Non-farmers

	Non-Farmers' Income per Annum (Ksh)		
	Mean	**Minimum**	**Maximum**
Thiboro	52,600	20,400	84,000
Mau Mau Bridge	39,600	30,000	48,000
Maili Saba	69,960	20,400	207,000
ALL	**54,053**	**20,400**	**207,000**

3.3.3 Household expenditure/Consumption

Household expenditure is a reflection of income and is perceived by the local community as an indicator of wealth. People with a higher income tend to spend more, thus showing higher economic status. For the purpose of this study, respondents were asked to give their annual expenditures ranging from food, education, to clothing. It was noted that people were more enthusiastic to give information on their expenditure than their income. In several instances, the expenditures reported were higher than the income.

Understandably, some were also reluctant to disclose some of their sources of income, such as illegal beer brewing or prostitution. It can therefore be argued that household expenditure was a clearer indicator of wealth status among the study community. A summary of household expenditure is given in table 6.

Table 6 Household expenditure per annum

Site	**Household Expenditure per Annum**					
	Farmers			Non-farmers		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Thiboro	147,371	64,400	244,200	36,000	14,400	50,400
Mau Mau Bridge	128,950	79,800	190,000	43,116	29,250	63,500
Maili Saba	65,428	47,900	92,000	61,506	24,800	161,430
ALL	**119,020**	**47,900**	**244,200**	**49,535**	**14,400**	**161,430**

3.3.4 Possession of durable goods

Farmers showed significant wealth differences, in comparison with non-farmers, in the possession of durable goods. High market value durable consumer possessions, such as a car, motorbike, fridge, and television, were not recorded among non-farmers. 10% of the farmers had a car, 16% had a fridge and 58% had a television.

Ownership of durable consumer goods with a relatively lower market value was recorded between the two groups. 32% of farmers had bicycles and 100% had radios. Only 9 % of non-farmers had bicycles and 91% had radios. This was an indication of the differences in purchasing powers of the farmers and non-farmers. The difference in the level of possession of durable goods is illustrated in table 7.

Table 7 Level of possession of durable consumer goods

		Car	Motorbike	Fridge	Television	Bicycle	Radio
Thiboro	Farmers	28%	0%	43%	71%	14%	100%
	Non-farmers	0%	0%	0%	0%	33%	100%
Mau Mau Bridge	Farmers	0%0%	28%	0%	57%	43%	100%
	Non-farmers	0%	0%	0%	0%	0%	100%
Maili Saba	Farmers	0%	0%	0%	40%	40%	100%
	Non-farmers	0%	0%	0%	0%	0%	80%
All	**Farmers**	**10%**	**10%**	**16%**	**58%**	**32%**	**100%**
	Non-farmers	**0%**	**0%**	**0%**	**0%**	**9%**	**91%**

3.3.5 Type of House Building Materials

The type of building materials used in constructing a respondent's dwelling house was noted. No distinction was made between houses that were rented and houses that were owner-occupied. In Thiboro, well-spaced houses with stone walls and iron roofs were dominant. In Mau Mau Bridge, the houses were built from permanent and semi-permanent material.

The housing situation in Maili Saba was remarkably different from the other two sites. Use of adobe or pole/mud walls was dominant. The type of housing in Maili Saba is a reflection of both the community's relative wealth status as well as the prevailing uncertainty on land tenure.

A summary of the type of building materials in each of the three study sites is presented in table 8 below.

Table 8 Types of building materials in different study sites

		ROOF		WALLS					FLOOR	
		Tiles	Iron Sheets	Masonry	Timber	Iron Sheets	Adobe	Mud	Cemented	Earthen
Thiboro	Farmers	43%	57%	43%	0%	57%	0%	0%	100%	0%
	Non-Farmers	0%	100%	0%	0%	100%	0%	0%	67%	33%
Mau Mau Bridge	Farmers	14%	86%	14%	43%	43%	0%	0%	71%	29%
	Non-farmers	0%	100%	0%	0%	100%	0%	0%	67%	33%
Maili Saba	Farmers	0%	100%	0%	0%	10%	40%	40%	0%	100%
	Non-farmers	0%	100%	0%	20%	60%	0%	20%	0%	100%
ALL	**Farmers**	**21%**	**79%**	**21%**	**16%**	**42%**	**11%**	**10%**	**64%**	**26%**
	Non-farmers	**0%**	**100%**	**0%**	**9%**	**82%**	**0%**	**9%**	**45%**	**55%**

3.3.6 Household Lighting and Cooking Facilities

The type of energy used in lighting housing or in cooking was seen as an indicator of wealth. For the three sites, a summary of different energy sources is given in tables 9 and 10.

Table 9 Household lighting

		Electricity	**Pressure lamp**	**Hurricane lamp**	**Tin lamp**
Thiboro	Farmers	71%	43%	57%	43%
	Non-Farmers	0%	67%	0%	100%
Mau Mau Bridge	Farmers	28%	0%	100%	0%
	Non-farmers	0%	0%	100%	0%
Maili Saba	Farmers	0%	0%	80%	100%
	Non-farmers	0%	0%	60%	60%
ALL	**Farmers**	**37%**	**16%**	**79%**	**42%**
	Non-farmers	**0%**	**18%**	**45%**	**37%**

Table 10 Household cooking facilities

		Electricity	Gas	Paraffin	Charcoal	Firewood
Thiboro	Farmers	14%	43%	71%	100%	71%
	Non-Farmers	0%	0%	100%	100%	67%
Mau Mau Bridge	Farmers	0%	28%	100%	100%	43%
	Non-farmers	0%	0%	100%	100%	33%
Maili Saba	Farmers	0%	0%	100%	80%	100%
	Non-farmers	0%	0%	80%	40%	40%
ALL	**Farmers**	**5%**	**26%**	**89%**	**89%**	**68%**
	Non-farmers	**0%**	**0%**	**73%**	**73%**	**45%**

3.3.7 Possession of Farm Implements amongst Farmers

The type of farm implements can be a significant indicator of wealth differentiation among farmers at different study sites. The incidence of implement ownership is presented in table 11.

Table 11 Incidence of Possession of Farm Implements amongst Farmers

	Panga	Jembe (hoe)	Folk	Shovel	Watering can	Hose pipe	Water pump	Knapsack sprayer
Thiboro	100%	100%	100%	100%	86%	71%	28%	86%
Mau Mau Bridge	100%	100%	100%	71%	100%	0%	14%	57%
Maili Saba	100%	100%	100%	20%	0%	0%	0%	20%
ALL	**100%**	**100%**	**100%**	**63%**	**62%**	**24%**	**14%**	**54%**

In general, the type and value of equipment are related to the nature and level of irrigation activities being carried out. The farmers in Thiboro have invested in high value specialised farm implements that facilitate intensive irrigation production. The Maili Saba farmers have a minimum of farm implements, compared to both Thiboro and Mau Mau Bridge.

3.3.8 Hiring of Casual Labour

Farmers usually use three categories of labour, i.e. 'self' labour, 'unpaid' labour from other members of household and 'hired' labour. Capacity to hire outside labour is perceived as an indicator of relative wealth. The incidence of such labour sourcing is presented in table 12.

Table 12 Reported incidence of farm labour sourcing

	Reported Incidence of Farm Labour Sourcing		
Study Site	Self Labour	Unpaid Labour	Hired Labour
Thimboro	100%	80%	100%
Mau-Mau Bridge	86%	86%	43%
Mali Saba	100%	60%	40%

4 WEALTH RANKING OF THE COMMUNITIES

4.1 Assignment of Weights to Different Wealth Indicators

To establish a clearer picture of wealth distribution, a rating scale of arbitrary weights was formulated for all the variables surveyed (table 13). The scale was then used to estimate weights for each respondent.

Table.13 Weighting framework for different wealth indicators

Variables	Weight	Variables	Weight
Income Ranges		**House Construction Materials**	
<= 15,000	5	Tiles	20
15,001 – 30,000	10	Iron Sheets	10
30,001 – 60,000	15	Masonry	30
60,001 – 90,000	20	Timber	10
90,001 – 120,000	25	Adobe	8
120,001 – 150,000	30	Mud	5
150,001 – 180,000	35	Cemented floor	15
180,001 – 210,000	40	Earthen floor	1
210,001 – 240,000	45		
>=240,001	50		
Durable Goods		**Household Facilities and Amenities**	
Car	40	Electricity	20
Motorbike	20	Pressure lamp	8
Fridge	10	Hurricane lamp	5
Television	5	Tin lamp	1
Bicycle	5	**Cooking fuel**	
Radio	1	Electricity	20
Wheelbarrow	2	Gas	15
		Paraffin	7
		Charcoal	4
		Firewood	2
		Sanitation	
		Pit latrine	2
		Flush latrine	8
Farm Implements		**Labour**	
Panga	1	Self labour	1
Jembe	1	Unpaid labour	1
Folk	1	Hired labour	4
Shovel	1		
Watering can	1		
Hose pipe	4		
Water pump	10		
Knapsack sprayer	3		

4.2 Ranking of Respondents on the Basis of Wealth Weights

The respondents were ranked in a descending order, from the one with the highest total weight rating to the lowest, for all the 30 respondents interviewed in the three sites. This is summarised in table 14 below. Details of the wealth ranking are contained in annex 2.

Table 14 Outcome of wealth ranking for surveyed respondents

Rank	Respondent	Total Weight
1	TF1	317
2	TF7	235
3	MF5	212
4	TF2	192
5	TF4	158
6	MF3	128
7	MF6	114
8	TF6	112
9	MF2	98
10	MF7	94
11	TF3	89
12	SF5	88
13	MF4	87
14	SF2	86
15	TN10	83
16	TF5	82
17	SN10	77
18	SF3	75
19	TN9	75
20	MF1	72
21	MN10	71
22	MN8	69
23	SF1	58
24	SN7	53
25	MN9	52
26	SN6	48
27	TN8	48
28	SN8	47
29	SF4	44
30	SN9	41

Farmers were marked ‘F’, while non-farmers were marked ‘N’. To differentiate between the farmers in the three sites, ‘T’, ‘M’ and ‘S’ were used to represent Thiboro, Mau Mau Bridge and Maili Saba, respectively. Thus, farmer number five from Thiboro was labelled ‘TF5’, likewise, a non-farmer number nine from Maili Saba was labeled ‘SN9’.

4.3 Observation on the Ranking Outcome

From this ranking, the following observations can be made:

- The first 10 positions are taken by farmers. The first non-farmer appears on the 15th position out of the 30 in the ranking. The non-farmers occupy 8 of the bottom 10 positions. This means that farmers are generally economically better off than non-farmers living in the same community.
- Respondents from Thiboro and Mau Mau Bridge are economically better off than their counterparts in Maili Saba. Not a single respondent from Maili Saba appears in the top 10 of the ranking. Instead, they take 6 of the bottom 10 positions.
- Upon disaggregating the respondents in their respective sites, farmers still come out first in the rank.
  - In Thiboro they take the first 6 positions out of 10
  - In Mau Mau Bridge, they take the first 7 positions
  - In Maili Saba, they take the first 2 positions

5 GENERAL REMARKS, CONSTRAINTS AND RECOMMENDATIONS

5.1 General Remarks

Farmers within the study sites appear to be comparatively better off, in terms of wealth status, than non-farmers. This applies in particular to Maili Saba, where community members have a choice to either engage in irrigated farming or pursue other economic activities. Those who practise irrigated farming generally surpass non-farmers in wealth ranking.

For those who practise irrigation, experience is advantageous, since 6 of the top 10 positions in the wealth ranking are occupied by farmers who have 10 or more years' irrigation experience (see annex 2).

5.2 Factors Constraining Irrigated Farming

Farmers from various study sites cited a range of constraints, as summarised in table 15 below.

Table 15 Factors constraining irrigated farming

Type of constraint	Study Site		
	Thiboro	Mau-Mau Bridge	Maili-Saba
Inadequate irrigation water	x	xx	xxx
Poor input availability	xx	xxx	xx
High input costs	xx	xxx	xxx
Inadequate technical support	xx	xx	xxx
Lack of timely market information	x	x	xx
Poor access roads	xx	xx	xxx
Lack of credit for capital development	xxx	xxx	xxx
Lack of credit for input supply	xxx	xxx	xxx
Theft of produce			xxx

x – a minor problem
xx – a problem
xxx – a major problem

5.3 Recommendations

If irrigated agriculture is to continue contributing to the welfare of peri-urban farming households, the following recommendations are appropriate:

- Policy changes need to be effected with a view to incorporating urban agriculture as a legitimate urban land-use
- Implementation of well-structured technical support to urban irrigators, not only regarding crop husbandry, but also on environmental implications
- Formation of urban farmers associations or co-operatives which can deliberate and act on issues such as marketing, input supply as well as credit.

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Annexes

Annex 1

Questionnaire results

Annex A Questionnaire results

- Total Number of Respondents – 30

- Gender Males – 53%
  Females – 47 %
- Level of Education
  No education – 6%
  Primary Level – 40 %
  Secondary level – 50 %
  Post-Secondary/Tertiary training – 4%

- Main Occupation
  Farming – 60%
  Non-Farmers- 40%

- Land Under cultivation
  Mean – 0.71 ha
  Minimum – 0.10 ha
  Maximum – 7.1 ha

- Land under irrigation
  Mean – 0.41 ha
  Minimum – 0.05 ha
  Maximum – 2.5 ha

- Years of Irrigation
  Mean – 8.3 yrs
  Minimum – 1 yr
  Maximum – 30yrs

WEALTH INDICATORS

INCOME

- Farmers' farm income per annum
  Mean – Ksh 95,782
  Minimum – Ksh 14,000
  Maximum –Ksh 247,700

- Farmers' non-farm income per annum
  Mean – Ksh 133,338
  Minimum – 0
  Maximum – Ksh 212,428

- Non-farmers' income
  Mean – Ksh 55,225
  Minimum – Ksh 20,400
  Maximum – Ksh207,000

HOUSEHOLD EXPENDITURE

- Farmers
  Mean – Ksh 119,020
  Minimum- Ksh 47,900
  Maximum – Ksh 244, 200

- Non-Farmers
  Mean – Ksh 49,535
  Minimum – Ksh 14,400
  Maximum – Ksh 161,430

DETAILS AT SPECIFIC SITES

INCOME

THIBORO

Respondent	Farm Income (Ksh)	Non-Farm Income (Ksh)	Total (Ksh)
TF1	247,700	1,182,000	1,429,700
TF2	93,000	180,000	273,000
TF3	126,000	-	126,000
TF4	282,000	107,000	389,500
TF5	83,000	-	-
TF6	52,000	18,000	70,000
TF7	245,000	-	-
TN8	-	20,400	20,400
TN9	-	53,400	53,400
TN10	-	84,000	84,000

MAU MAU BRIDGE

Respondent	Farm Income	Non-Farm Income	Total
MF1	96,000	10,000	106,00
MF2	57,600	84,400	142,000
MF3	84,000	120,000	204,000
MF4	100,000	36,000	136,000
MF5	78,000	240,000	318,000
MF6	116,000	24,000	140,000
MF6	62,000	36,000	98,000
MN8	-	40,800	40,800
MN9	-	30,000	30,000
MN10	-	48,000	48,000

MAILI SABA

Respondent	Farm Income (Ksh)	Non-Farm Income (Ksh)	Total (Ksh)
SF1	49,100	-	49,100
SF2	19,000	96,000	115,000
SF3	14,000	64,800	78,800
SF4	50,000	-	50,000
SF5	77,000	84,000	161,000
SN6	-	20,400	20,400
SN7	-	60,000	60,000
SN8	-	36,000	36,000
SN9	-	264,000	264,000
SN10	-	207,000	207,000

HOUSEHOLD CONSUMER DURABLES

THIBORO

Respond -ents	Household Consumer Durables						
	Car	M/Bike	Fridge	Television	Bicycle	Radio	W/Barrow
TF1	*	-	*	*	*	*	*
TF2	-	-	*	*	-	*	*
TF3	-	-	-	*	-	*	-
TF4	-	-	-	*	-	*	*
TF5	-	-	-	-	-	*	*
TF6	-	-	-	-	-	*	*
TF7	*	-	*	*	-	*	*
TN8	-	-	-	-	-	*	-
TN9	-	-	-	-	-	*	-
TN10	-	-	-	-	*	*	-

* Indicates household has item

MAU MAU BRIDGE

Respond -ents	Household Consumer Durables						
	Car	M/Bike	Fridge	Television	Bicycle	Radio	W/Barrow
MF1	-	-	-	-	-	*	-
MF2	-	-	-	*	-	*	*
MF3	-	-	-	*	-	*	-
MF4	-	-	-	-	*	*	-
MF5	-	*	-	*	*	*	*
MF6	-	*	-	*	-	*	-
MF7	-	-	-	-	*	*	-
MN8	-	-	-	-	-	*	-
MN9	-	-	-	-	-	*	*
MN10	-	-	-	-	-	*	-

MAILI SABA

Respond-ents	Household Consumer Durables						
	Car	M/Bike	Fridge	Television	Bicycle	Radio	W/Barrow
SF1	-	-	-	-	-	*	*
SF2	-	-	-	*	*	*	-
SF3	-	-	-	*	*	*	*
SF4	-	-	-	-	-	*	-
SF5	-	-	-	-	-	*	-
SN6	-	-	-	-	-	*	-
SN7	-	-	-	-	-	-	-
SN8	-	-	-	-	-	*	-
SN9	-	-	-	-	-	*	-
SN10	-	-	-	-	-	*	*

HOUSE CONSTRUCTION MATERIALS

THIBORO

	Roof		Walls					Floor	
	Tiles	Iron Sheets	Concrete	Timber	Adobe	Mud	Iron Sheets	Cemented	Earthen
TF1	*	-	*	-	-	-	-	*	-
TF2	*	-	*	-	-	-	-	*	-
TF3	-	*	-	-	-	-	*	*	-
TF4	-	*	-	-	-	-	*	*	-
TF5	-	*	-	-	-	-	*	*	-
TF6	-	*	-	-	-	-	*	*	-
TF7	*	-	*	-	-	-	-	*	-
TN8	-	*	-	-	-	-	*	-	*
TN9	-	*	-	-	-	-	*	*	-
TN10	-	*	-	-	-	-	*	*	-

MAU MAU BRIDGE

	Roof		Walls					Floor	
	Tiles	Iron Sheets	Concrete	Timber	Adobe	Mud	Iron Sheets	Cemented	Earthen
MF1	-	*	-	-	-	-	*	-	*
MF2	-	*	-	-	-	-	*	*	-
MF3	-	*	-	*	-	-	-	*	-
MF4	-	*	-	*	-	-	-	-	*
MF5	*	-	*	-	-	-	-	*	-
MF6	-	*	-	*	-	-	-	*	-
MF7	-	*	-	-	-	-	*	*	-
MN8	-	*	-	-	-	-	*	*	-
MN9	-	*	-	-	-	-	*	-	*
MN10	-	*	-	-	-	-	*	*	-

MAILI SABA

	Roof		Walls					Floor	
	Tiles	Iron Sheets	Concrete	Timber	Adobe	Mud	Iron Sheets	Cemented	Earthen
SF1	-	*	-	-	*	-	-	-	*
SF2	-	*	-	-	*	-	-	-	*
SF3	-	*	-	-	-	*	-	-	*
SF4	-	*	-	-	-	*	-	-	*
SF5	-	*	-	-	-	-	*	-	*
SN6	-	*	-	-	-	-	*	-	*
SN7	-	*	-	-	-	-	*	-	*
SN8	-	*	-	-	-	-	*	-	*
SN9	-	*	-	-	-	*	-	-	*
SN10	-	*	-	*	-	-	-	-	*

HOUSE LIGHTING, COOKING FUELS AND SANITATION FACILITIES

THIBORO

Respon dents	Lighting				Cooking Fuel					Sanitation	
	Elect-ricity	Pressure Lamp	Hurricane lamp	Tin Lamp	Elect-ricity	Gas	Charcoal	Paraffin	Fire wood	Flush toilet	Pit latrine
TF1	*	*	-	-	*	*	*	-	*	*	*
TF2	*	-	-	-	-	*	*	-	-	*	*
TF3	-	-	*	-	-	-	*	*	-	-	*
TF4	*	-	*	-	-	-	*	*	*	-	*
TF5	-	*	-	*	-	-	*	*	*	-	*
TF6	*	*	*	*	-	-	*	*	*	-	*
TF7	*	-	*	*	-	*	*	*	*	*	-
TN8	-	-	-	*	-	-	*	*	*	-	*
TN9	-	*	-	*	-	-	*	*	*	-	*
TN10	-	*	-	*	-	-	*	*	-	*	*

MAU MAU BRIDGE

Respon-dents	Lighting				Cooking Fuel					Sanitation	
	Elect-ricity	Pressure Lamp	Hurricane Lamp	Tin Lamp	Elect-ricity	Gas	Charcoal	Paraffin	Fire wood	Flush toilet	Pit latrine
MF1	-	-	*	-	-	-	*	*	*	-	*
MF2	-	-	*	-	-	-	*	*	*	-	*
MF3	*	-	*	-	-	*	*	*	-	-	*
MF4	-	-	*	-	-	-	*	*	*	-	*
MF5	*	-	*	-	-	*	*	*	-	-	*
MF6	-	-	*	-	-	-	*	*	-	-	*
MF7	-	-	*	-	-	-	*	*	-	-	*
MN8	-	-	*	-	-	-	*	*	-	-	*
MN9	-	-	*	-	-	-	*	*	-	-	*
MN10	-	-	*	-	-	-	*	*	*	-	*

MAILI SABA

Respon-dents	Lighting				Cooking Fuel					Sanitation	
	Elect-ricity	Pressure Lamp	Hurricane Lamp	Tin Lamp	Elect-ricity	Gas	Charcoal	Paraffin	Fire wood	Flush toilet	Pit latrine
SF1	-	-	*	*	-	-	*	*	*	-	*
SF2	-	-	*	*	-	-	*	*	*	-	*
SF3	-	-	*	*	-	-	*	*	*	-	*
SF4	-	-	-	*	-	-	-	*	*	-	*
SF5	-	-	*	*	-	-	*	*	*	-	*
SN6	-	-	-	*	-	-	*	*	*	-	*
SN7	-	-	*	*	-	-	-	*	-	-	*
SN8	-	-	-	*	-	-	-	*	-	-	*
SN9	-	-	*	-	-	-	-	*	-	-	*
SN10	-	-	*	-	-	-	*	-	*	-	*

FARM IMPLEMENTS AND FARM LABOUR

THIBORO

Respon-dents	Farm Implements								Farm Labour		
	Panga	Jembe	Jolk Jembe	Shovel	Watering can	Hose pipe	Pump	Knapsack Sprayer	Self	Unpaid from household	Hired
TF1	*	*	*	*	*	*	*	*	*	*	*
TF2	*	*	*	*	*	*	*	*	*	*	*
TF3	*	*	*	*	-	-	-	*	*	*	*
TF4	*	*	*	*	*	*	-	-	*	*	*
TF5	*	*	*	*	*	*	-	*	*	*	*
TF6	*	*	*	*	*	-	-	*	*	*	*
TF7	*	*	*	*	*	*	-	*	*	*	*

MAU MAU BRIDGE

Respon-dents	Farm Implements								Farm Labour		
	Panga	Jembe	Jolk Jembe	Shovel	Watering can	Hose pipe	Pump	Knapsack Sprayer	Self	Unpaid from household	Hired
MF1	*	*	*	*	*	-	-	-	*	*	-
MF2	*	*	*	*	*	-	-	*	*	-	*
MF3	*	*	*	*	*	-	-	*	*	*	*
MF4	*	*	*	-	*	-	-	-	*	*	-
MF5	*	*	*	*	*	-	-	*	-	*	*
MF6	*	*	*	*	*	-	*	-	*	*	-
MF7	*	*	*	-	*	-	-	*	*	*	-

MAILI SABA

Respon-dents	Farm Implements								Farm Labour		
	Panga	Jembe	Jolk Jembe	Shovel	Watering can	Hose pipe	Pump	Knapsack Sprayer	Self	Unpaid from household	Hired
SF1	*	*	*	-	-	-	-	-	*	*	-
SF2	*	*	*	-	-	-	-	-	*	*	*
SF3	*	*	*	*	-	-	-	-	*	*	*
SF4	*	*	*	-	-	-	-	-	*	-	-
SF5	*	*	*	-	-	-	-	*	*	-	-

Annex 2

Wealth ranking

WEALTH RANKING OF THE COMMUNITIES

RANK	Respon-dent	Farm Income	Non-Farm Income	Car	Motorbike	Fridge	Tele-vision	Bicycle	Radio	Wheel barrow	Roof	Walls	Floor	Lighting	Cooking Fuel	Sani-tation	TOTAL
1	TF1	50	50	50	0	10	5	5	1	2	20	30	15	28	41	10	317
2	TF7	50	0	40	0	10	5	0	1	2	20	30	15	26	26	10	235
3	MF5	20	45	0	20	0	5	5	1	2	20	30	15	25	22	2	212
4	TF2	25	35	0	0	10	5	0	1	2	20	30	15	20	19	10	192
5	TF4	50	25	0	0	0	5	0	1	2	10	10	15	25	13	2	158
6	MF3	20	25	0	0	0	5	0	1	0	10	10	15	25	11	2	124
7	MF6	25	10	0	20	0	5	0	1	0	10	10	15	5	11	2	114
8	TF6	15	10	0	0	0	0	0	1	2	10	10	15	34	13	2	112
9	MF2	15	20	0	0	0	5	0	1	2	10	10	15	5	13	2	98
10	MF7	20	15	0	0	0	0	5	1	0	10	10	15	5	11	2	94
11	TF3	30	0	0	0	0	5	0	1	0	10	10	15	5	11	2	89
12	SF5	25	20	0	0	0	0	0	1	0	10	10	1	6	13	2	88
13	MF4	25	15	0	0	0	0	5	1	0	10	10	1	5	13	2	87
14	SF2	10	25	0	0	0	5	5	1	0	10	8	1	6	13	2	86
15	TN10	0	20	0	0	0	0	5	1	0	10	10	15	9	11	2	83
16	TF5	20	0	0	0	0	0	0	1	2	10	10	15	9	13	2	82
17	SN10	0	40	0	0	0	0	0	1	2	10	10	1	5	6	2	77
18	SF3	5	20	0	0	0	5	5	1	2	10	5	1	6	13	2	75
19	TN9	0	15	0	0	0	0	0	1	0	10	10	15	9	13	2	75
20	MF1	25	5	0	0	0	0	0	1	0	10	10	1	5	13	2	72
21	MN10	0	15	0	0	0	0	0	1	0	10	10	15	5	13	2	71
22	MN8	0	15	0	0	0	0	0	1	0	10	10	15	5	11	2	69
23	SF1	15	0	0	0	0	0	0	1	2	10	8	1	6	13	2	58
24	SN7	0	20	0	0	0	0	0	1	0	10	10	1	2	7	2	53
25	MN9	0	10	0	0	0	0	0	1	2	10	10	1	5	11	2	52
26	SN6	0	10	0	0	0	0	0	1	0	10	10	1	1	13	2	48
27	TN8	0	10	0	0	0	0	0	1	0	10	10	1	1	13	2	48
28	SN8	0	15	0	0	0	0	0	1	0	10	10	1	1	7	2	47
29	SF4	15	0	0	0	0	0	0	1	0	10	5	1	1	9	2	44
30	SN9	0	10	0	0	0	0	0	1	0	10	5	1	5	7	2	41

Farmers Ranking Versus Years of Irrigation

Rank	Farmer Identification	Years of irrigation
1	TF1	14
2	TF7	30
3	MF5	12
4	TF2	16
5	TF4	14
6	MF3	2
7	MF6	8
8	TF6	7
9	MF2	10
10	MF7	4
11	SF5	4
12	MF4	20
13	SF2	5
14	TF3	8
16	TF5	3
18	SF3	10
19	MF1	1
23	SF1	6
29	SF4	1

Average number of years that farmers have been irrigating = 8.3 years