Informal Irrigation in the Peri-urban Zone of Kumasi, Ghana

Findings from an initial questionnaire survey

G A Cornish
J B Aidoo

KAR Project R7132

Report OD/TN 97
March 2000

HR Wallingford

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Kumasi, Ghana

DFID Department for International Development

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Contract

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 environment. Fieldwork has been conducted in and around Kumasi, Ghana, and Nairobi, Kenya.

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Executive Summary

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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 Kumasi, Ghana, 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 Nairobi is published as OD/TN 98. Earlier work, also 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 Nairobi report, identifies. The results of these second stage studies will form part of the final output of this project, available in March 2001.

The Survey Method
Following earlier studies by the UK's Natural Resources Institute a 40km radius around Kumasi was taken to delimit the study area. An initial scoping survey was carried out in this area which readily identified 100 villages or other locations where irrigation is practised. To select sites for detailed interviews the area was divided into eight equal segments and eight sites were selected per segment, 64 in total. (One of these was abandoned during the survey).

In conducting the detailed interviews information was gathered through a combination of participatory discussion at the whole village level and structured interviews with selected growers. At the community interview, baseline information was collected on the history of irrigated vegetable farming, the level

of interest shown by the farming population, gender and indigene-migrant proportions, sources of water, common methods of conveying water, irrigated vegetables grown and their popularity amongst the farmers.

The individual farmer interview covered personal and household information, household socio-economic considerations, plot characteristics, water management, cropping pattern, plot input-output data and farmers' conception of constraints. Farmers were selected for interview based on the information obtained during discussion at the community level.

Survey Findings

The extent and role of informal irrigation

FAO statistics relating to irrigation in Ghana report the total land area under formal water management as 6,400 ha but the same data set reports no land under informal irrigation in wetlands and valley bottoms, although this practice is known to exist. This survey shows that there are at least 12,700 households, representing 89,000 individuals, in the study area cultivating roughly 11,500 ha, almost double the "formal" irrigation area in the whole of Ghana, and it is believed that similar, extensive areas of informal irrigation exist around Accra and Takoradi. These areas of informal irrigated production are unsupported and overlooked by the extension services and policy makers alike.

Almost all of the irrigation activity is occurring in the urban fringe and in the peri-urban zone - an area influenced by the presence of the urban centre but still rural or semi-rural in appearance. There is very little irrigated agriculture in the urban centre of Kumasi. Although production is physically distant from the urban centre the presence of the large urban market is essential in explaining the strength of the sector. Almost 75% of farmers market their produce in Kumasi and 40% of the traders buying from the field sell into Kumasi.

Overall management of dry season vegetable production (DSVP) within the household normally rests with the husband. On average only 17% of DSVP farmers are women farming independently. However, women provide about 36% of the total labour input for all tasks, with particularly high inputs for irrigation (46%) and harvesting (60%).

Informal irrigation is not new in the region. In 40% of the villages surveyed irrigation has been practised for more than 30 years. However, there is evidence of increasing numbers of farmers moving into irrigation over the last 10 years. Almost 60% of the villages reported that the number of farmers engaged in DSVP has increased significantly only in the period since 1990. In the 63 villages surveyed an average of 44% of farmers are involved in irrigation. The level of activity varies greatly from site to site, dependant primarily on the availability of water but 20% of the villages report that 60% or more of farmers are involved in DSVP.

84% of farmers report that irrigated vegetables provide the largest source of cash income to the household. Gross incomes per hectare for different crop types varied widely but the average is about US$ 1,200 /ha. More detailed studies to

determine the variable costs associated with different crops will be carried out in the second stage of study.

Irrigation characteristics
The condition of the irrigated plot varies greatly from sites with very uniform and well-maintained beds to sites that are only partially cleared and have no land forming. The size of the irrigated holding also varies. The overall mean is 0.9 ha but a small number of farmers (approximately 5%) report plots of 3 ha or more.

A range of irrigation practices exists with regard to water source, method of water conveyance and application, the size and layout of the irrigated plot and the level of investment in equipment. Perennial rivers are the most widely used single source but the use of shallow dug outs and water from stream pools are almost equally widespread. The water source often changes as the season progresses, initially relying on streams or stream pools and later using dug outs.

There is no evidence of the use of gravity, i.e. ground slope, and earth channels to convey water from the source to the field. Nor is there any use of small dams or "improved wells" to store surface run-off, improve groundwater recharge or improve the yield of existing dug outs. For the majority of farmers (73%) water must be carried from source to field. 24% of farmers make regular or occasional use of a motorised pump. The remaining 3% take water from the pressurised mains supply of the city

Half the respondents make use of an oil drum at the field edge to store water carried from the source. Water is then transferred from the drum to the crop. Only 25% carry water from the source and apply it directly to the crop. Half of the farmers interviewed use some paid labour to carry out irrigation and half rely solely on unpaid labour for this task. Where farmers pay for irrigation there is considerable variation in cost. In particular, payment per barrel appears to carry a very high cost compared with monthly or daily payment for irrigation but this requires further investigation. Where payment is per barrel farmers are paying as much as $US 5 per cubic metre. Given the very high costs of manual carrying it is likely that water is applied very sparingly to the crop, but this also requires further quantification in the second stage.

The total numbers of men and women providing labour for watering are approximately equal but a much higher percentage of the women are paid for their labour. This reflects the fact that women are often paid to carry water over a considerable distance from source to field side where the water is temporarily stored in a 200 litre oil drum The farmer himself will then fill a bucket, tin or watering can from the oil drum and apply water to the crop.

The distance that water is conveyed from source to field seems independent of the type of source. Roughly half the farmers using any source move water 50m or less from source to field, but for each source a minority of farmers (8 – 10%) are carrying (or pumping) water over 200m. The physical effort required to repeatedly carry water, often uphill, over this distance is hard to imagine but it does in part explain the high cost associated with irrigation water. Low cost water lifting technologies such as the treadle pump may offer significant benefits to these farmers.

Equipment hire of high value items such as motorised pumps and sprayer and knapsack sprayers is relatively widespread, confirming that DSVP is a remunerative activity, well established in the cash economy of the region. It is not unreasonable to expect that if a new technology such as manual treadle pumps for water lifting was introduced then there could be significant opportunities for those buying the pumps to recoup their investment through hiring.

Water costs and water quality

The price for water paid by pump owners, and those paying labourers on a daily basis are roughly equal at about $US 125 over a 4 month season. Those hiring pumps pay approximately 2 ½ times more. Those paying for water per barrel may pay $US 480 over a season, almost 4 times that paid by those hiring day labour or by pump owners. Although the seasonal cost of owning and operating a pump is comparable with that of paying labour to carry water manually the volume of water provided by the pump will far exceed that lifted manually and where the owner chooses the pump can be hired out to generate additional income.

Concern over water quality is raised as much over water from dug outs as over water from the perennial streams. Although 25% of respondents believed the water to be unsafe to drink the largest part of this group draws water from dug outs. Thus, the concern of this research team and others over the high levels of organic pollution in the Subin and Oda rivers draining Kumasi and the perception that dugouts offer a cleaner water supply is not borne out in the views of the farmers.

Constraints Faced

The shortage or unavailability of credit is the outstanding constraint identified by all farmers, irrespective of their irrigation method. Similarly, concerns over the unavailability of labour or land are of least concern to all farm types. Access to land, in particular, is ranked very low as a constraint to production.

If no distinction is made between irrigation methods then access to markets, water and production inputs are seen as almost equally constraining. Amongst farmers with access to motorised pumps the second constraint after credit is produce marketing. This is understandable if these farmers cultivate a larger area than those relying on carried water and have higher levels of production which require marketing. The use of a pump implies that water is less of a constraining factor.

For the much larger group of farmers reliant on manually carried water, access to water ranks as the second greatest constraint after credit. Amongst farmers reporting water as a constraint 72% identified the effort or cost involved in obtaining water as being the limiting factor. Only 28% referred to scarcity of water at the source. Thus, although in an important number of locations water is scarce the much more common problem is that of moving sufficient water from the source to the crop.

Additional Field Studies

In order to gain a better understanding of the opportunities and constraints experienced by the peri-urban irrigators identified in this survey, a number of more focused studies are required to answer specific questions:

1. Although large numbers of farmers in many villages have taken up dry season irrigation it is not clear whether they are drawn from the more or less wealthy members of the community and whether irrigation has contributed significantly to their present wealth status. To answer these questions formal wealth ranking studies will be carried out in selected, representative villages.

2. Although farmers cite access to credit as the primary constraint to dry season irrigation, 37% of respondents currently use some form of credit. Further study is required to understand the forms of credit presently available to informal irrigators, how they operate and what makes them unattractive.

3. Problems of produce marketing are not unique to peri-urban irrigated production. However, some actions, such as co-operative action to plan planting and marketing, crop diversification and the use of reliable information on market prices can be used to overcome some of these problems. The survey did not identify the extent to which any of these mechanisms are, or could, be applied to improve marketing. A study of existing marketing strategies and potential ways of improving upon them will therefore be carried out in a number of representative villages.

4. The questionnaire survey gathered a large amount of information on crop types and areas, labour use, irrigation methods and estimates of total crop value. However, this information is based on farmer recall with no opportunity to validate estimates or account for variations in the price or quantity of inputs or outputs used or generated over the season. In particular, the survey was only able to gain a first indication of the adequacy of irrigation water supply under different irrigation methods. Second stage studies will therefore monitor the daily production activities of farmers representing the range of farm types.

Contents

Contents *continued*

Tables

Figures

Appendices

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.

The report 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 aim of identifying measures to improve output whilst minimising risks to health and the environment. Fieldwork has been conducted in and around Kumasi, Ghana, and Nairobi, Kenya.

The first stage of the research carried out in Kumasi, and reported here, used community and farmer surveys to provide an understanding of the following types of issue:

- The geographic distribution of irrigated cropping in and around Kumasi
- The contribution of irrigated cropping to family welfare and cash income
- The different irrigation practices that exist and their relative importance
- The extent to which irrigated vegetable production has expanded in recent years
- The importance of irrigated farming for men and women
- The 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 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 with most produce being sold for cash income. Exceptions to these distinctions can be identified – strategic central urban plots, readily seen and visited by car drivers, that grow and sell ornamental plants are widespread in Nairobi 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 40 km radius of Kumasi centre. Within this area pressure on land use and the associated problems of insecurity of tenure and rising land values are generally only seen in those villages closer to Kumasi but the other influences – market, service and input provision and resource pollution – are significant throughout the area.

Because irrigation tends to support more intensive, market orientated production the majority of sites identified lie in the peri-urban zone. Irrigation is also relatively widespread in the urban fringe – the boundary between urban and peri-urban where there is extensive development of high value housing. There is very little irrigated agriculture in the urban centre of Kumasi.

2.1 Traditional Land Use Patterns in the Area

Under traditional farming systems in Ghana, farmers do not deliberately water their crops, or plant during the dry season. Dry season vegetable production (DSVP) therefore marks a significant change from the traditional farming systems.

Boserup (1965) has postulated that traditional land use evolves from shifting cultivation which is more extensive when population is low, to intensive and permanent (tree) cropping as population pressure compels farmers to shorten fallow periods. With increasing pressure on land use farmers adopt improved methods – use of inorganic fertilizers, manure, agro-chemicals, improved seed varieties and more intensive agronomic practices. Farmers also move from traditional to new crops. The early propagators of cocoa in Ghana switched from oil palm production to cocoa when the latter became more lucrative (Hill, 1963). Benneh (1989) describes tenant farmers in Wasa who were sacked by their landlords for planting cassava instead of cocoa which was the principal condition of tenurial agreement. Apparently, cassava had become more profitable than cocoa in 1983 when the country experienced severe drought.

After nearly 100 years of cocoa cultivation, the semi-deciduous ecology of the area has broken down. It no longer supports cocoa, and most parts of this one time forest, have turned into grassland. For many farmers the growing of food crops – largely plantain and cassava – which succeeded cocoa in this region, has become less profitable, making the search for alternatives inevitable.

These are the factors that are leading many households in peri-urban Kumasi, and the Ashanti Region in general, into dry season vegetable cultivation.

3. THE SURVEY METHOD

Selection of a 40km radius around Kumasi to delimit the zone in which irrigation practices were studied was guided by the earlier peri-urban study (Village Characterisation Study) carried out by the UK's Natural Resources Institute under the Kumasi Natural Resources Management Research Project (Blake *et al* 1997).

3.1 Initial Scoping and Site Selection

An initial scoping survey was carried out within the area during November and December 1998. Informal visits were made to villages where the researchers knew that DSVP was practised. A group of farmers was easily gathered together in most villages and in discussion with them information was obtained on the number of farmers in the village using irrigation, types of water source used and the major crops grown. The names of other villages in the locality where DSVP was practised were also obtained and these villages were subsequently visited. In this way a total of 100 villages or sites within the 40 km radius were readily identified. These sites and the basic field notes collected at the time are included in Appendix 1. A further 6 sites were found close to the urban centre of Kumasi. These sites provided the sampling frame from which a sample was selected where detailed interviews were carried out. Information obtained during the scoping survey was used to guide the formulation of the subsequent detailed interviews, and the selection of sites where detailed interviews were carried out.

To select sites for detailed interviews the circle of 40-kilometre radius was divided into eight equal sectors. Eight sites per sector were selected for study, 64 in total. (One of these sites was later abandoned during the survey). In selecting the eight locations from those in each sector account was taken of the number of sites within the sector that used pumps or piped water so that the sample reflected this use. With regard to other factors the sample selection was essentially random. In addition to these 64 locations all 6 sites close to the city centre were incorporated into the interviews.

3.2 Data Collection at the Selected Sites

Information was gathered through a combination of participatory discussion at the whole village level and structured interviews with selected growers.

At the community interview baseline information was collected on the history of irrigated vegetable farming, the level of interest shown by the farming population, gender and indigene-migrant proportions, sources of water, common methods of conveying water, irrigated vegetables grown and their popularity amongst the farmers. A copy of the questions put to the community is included in Appendix 2. Discussion was encouraged amongst all the community members present to arrive at a consensus view or estimate of the individual factors.

The second level was the individual farmer or household interview. At the first sites visited nine farmers were selected for interview but it was soon realised that this sample size was too big given the time constraint and number of enumerators available. Consequently, the number of interviews was reduced to six in each location. Farmers were selected for interview based on the information obtained during discussion at the community level. The key factors used in selecting a cross-section of farm types were (a) the water source (flowing river, stream/river pool, dug out and mains supply) (b) the conveyance method (pumped or carried) and (c) the mix of male and female farmers and their origin, (indigenous or migrant).

The individual farmer interview covered personal and household information, household socio-economic considerations, plot characteristics, water management, cropping pattern, plot input-output data and farmer's conception of constraints. The questionnaire is reproduced in Appendix 2. The location of the survey sites is shown in Figure 1.

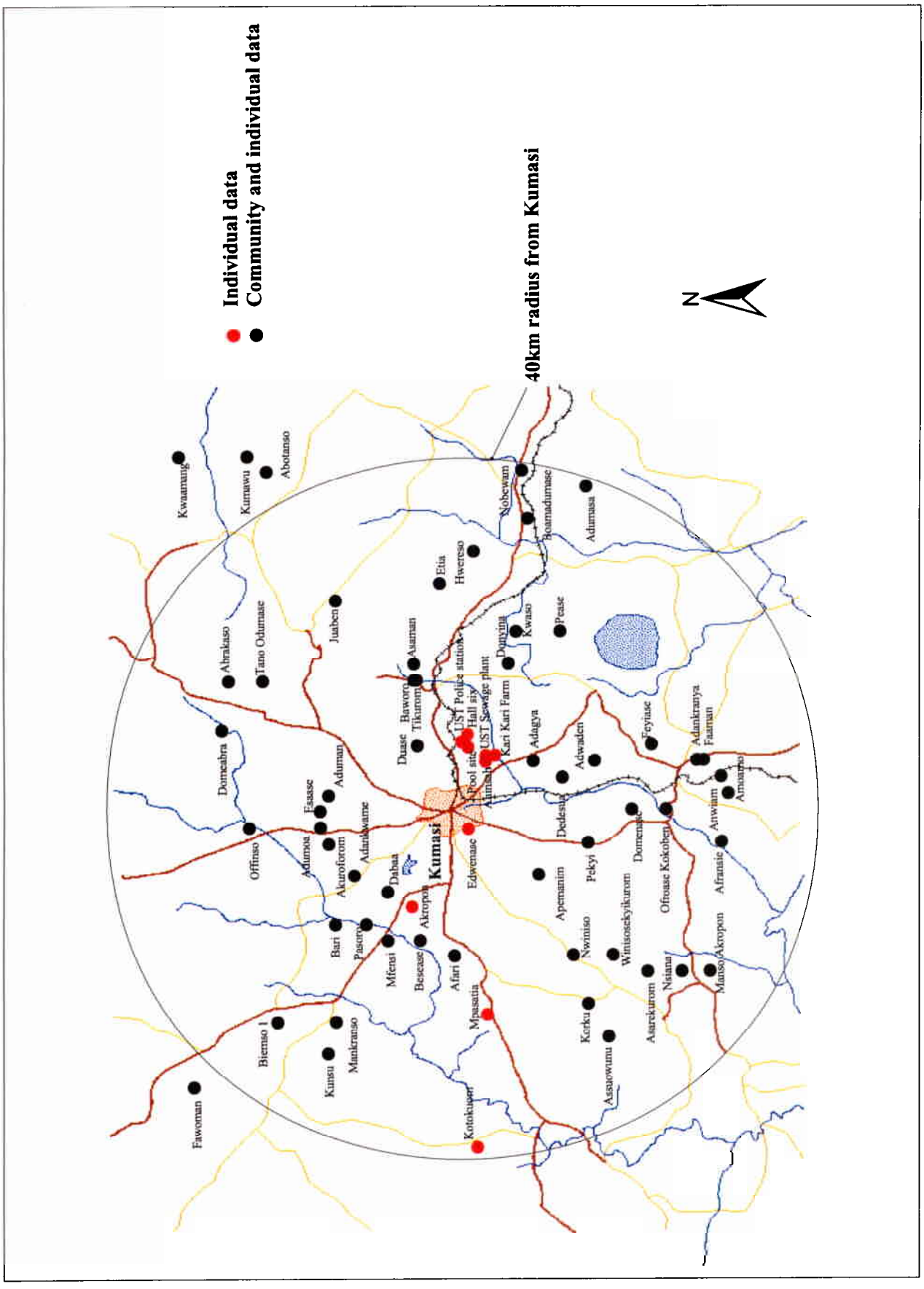


Figure 1 Location of Survey Sites

4. SURVEY FINDINGS

The structure of the following discussion follows the order of questioning used in the individual farmer questionnaire. The complete results from both the individual and community level questionnaires are set out in Appendix 3. The references in *Italics* throughout this section refer to the table number in Appendix 3 where the full results supporting the information presented, can be found. *Ind*. refers to data from individual farmer questionnaires and *Vill*. refers to data from the village or community level survey.

4.1 Personal and Household Background

Approximately 14% of the farmers interviewed are women *(Ind. 1.1)*. In the communities as a whole the mix of male to female farmers is 83% to 17% but there is variation about this with almost a quarter of the villages reporting that 25% or more of the irrigating farmers are women *(Vill. 12)*. Figure 2 shows the gender balance in the different communities. There is no obvious geographic trend in the ratio of male to female farmers. Roughly a third of those interviewed indicated that they work jointly with their spouse, although the nature of the joint arrangement was not specified *(Ind. 2.2a)*. The breakdown of labour between the sexes, report in Section 4.2, shows that men carry out most of the tasks except irrigation and harvesting *(Ind. 2.3)*.

The majority of farmers (40%) are aged between 30 and 39, the average age being 38. Women farmers tend to be older than the men – The women's average age is 43.6 while that of the men is 37.1 *(Ind. 1.2)*. The age of the farmers appears to refute the view of Holland *et al*, (1996) that it is predominately youth that are taking up DSVP as a lucrative source of income. Only 5% of those questioned are younger than 25. However, there is evidence that DSVP has recently grown and is continuing to grow as an important economic activity in the area. In 40% of the villages visited some irrigation has been practised for at least the last 30 years *(Vill. 4)*, but 60% of the communities report that the number of farmers involved in DSVP has increased significantly since 1990 *(Vill. 5)*. Traditionally a small amount of irrigation was carried out in the dry season, by women, to grow chillies and tomatoes for household consumption. It is only more recently that small-scale, but commercial, production has developed, carried out mainly by men.

Most of the farmers interviewed (90%) are ethnic Asantes, the remaining 10% split roughly equally between Fante and Grushi *(Ind. 1.3)*. There is no evidence of the non-Asante peoples achieving higher incomes than the Asantes but a higher percentage of the Grushi farmers have access to motorised pumps than amongst the Asantes or Fante. (39% of Grushi farmers use motorised pumps compared with 22% for both the Asante and Fante ethnic groups.)

Based on the community level data, 81% of DSVP farmers are indigenous to the Ashanti Region and 19% migrants from other regions. The distribution of migrants between villages is not uniform. 9 villages (14%) report over 40% of their irrigators are migrants but 16 villages (25%) report no migrants at all. There is no strong evidence that migrant farmers are quicker to move on when a site becomes exhausted of soil nutrients than indigenous farmers. 43% of indigenous farmers have farmed their present plot for 3 years or less, compared with 48% of migrants – the figures are similar.

In the 63 villages surveyed an average of 44% of farmers are involved in irrigation. The level of activity varies greatly from site to site, dependant primarily on the availability of water but 20% of the villages report that 60% or more of their farming population are involved in DSVP. Figure 3 shows the number of farmers practising irrigation at the sites where community surveys were conducted. Due to the influence of the few villages such as Ofoase Kokoben and Abotanso with more than 300 irrigators the mean number of irrigators is 128 but the median value of 50 more accurately reflects the number of irrigators found in many locations.

The average household size is seven members *(Ind. 1.6)*. The community level questionnaire, applied in 63 villages, estimates at least 8,000 irrigators in those villages. Linear extrapolation to the 100 sites identified in the initial scoping study indicates at least 12,700 farmers engaged in DSVP within the 40 km

radius of Kumasi. DSVP is therefore providing some direct benefit, through cash income to families, to some 89,000 people in the study area, at a conservative estimate.

4.2 Human, Social and Economic Factors

The huge majority of respondents (92%) see farming as their main occupation and 84% ranked DSVP as the primary contributor to total household income *(Ind. 1.9 and 2.2)*. The general picture is of farming households practising both irrigated vegetable production and rainfed cropping. These are the main sources of income with vegetables contributing more than the rainfed crops. Other diverse activities carried out by the farmer or spouse generate further income but in very few cases are these the main source of income. Thus, for those who have the opportunity, DSVP is a very important income source.

The income is used for a range of diverse purposes but it is notable that about a quarter of the respondents are raising money to build a house *(Ind. 2.1)*. This reflects one of the key aspirations of many Ghanaians generally, and the Asantes in particular - the desire to own a house. In the eyes of such people, a man is not judged by the positions he holds or accolades he has received, but most importantly, by the house or houses he is able to build.

4.2.1 The Use of Labour in DSVP

Questions were asked to determine the number of labourers engaged in the following eight tasks:

Land preparation	Applying manure
Planting / Transplanting	Applying agro-chemicals
Weeding	Irrigating
Applying chemical fertiliser	Harvesting

Information was dis-aggregated according to gender, whether children were involved (labourers under 15 years old) and whether the workers were paid or unpaid.

By adding the number of labourers of different classes that each respondent reported to be engaged in the different tasks the tasks can be ranked according to their use of labour. At this time no form of "labour equivalent" has been used to adjust for any perceived or actual difference in the amount of work done by a man, a woman or a child.

Figure 4 shows that land preparation and harvesting both account for one fifth of the total labour input. Below these two tasks come weeding, irrigation and planting/transplanting, each of these three tasks occupying about 15% of the total labour input. Applying chemical fertiliser uses about 9% of the total and finally, applying manure and agro chemicals are well down, each using about 2% of the total *(Ind. 2.3 (b))*.

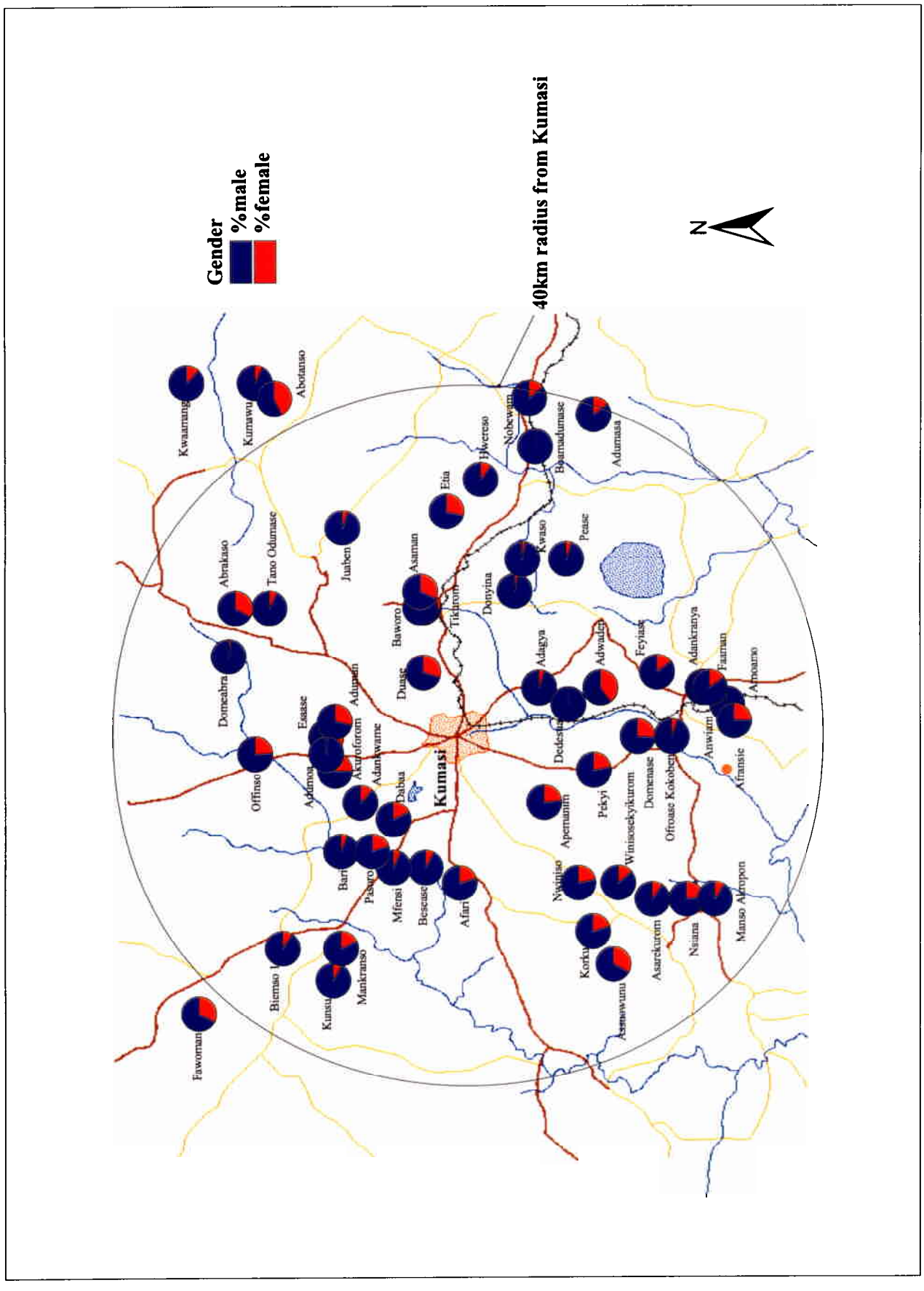


Figure 2 Ratio of Male and Female Irrigators

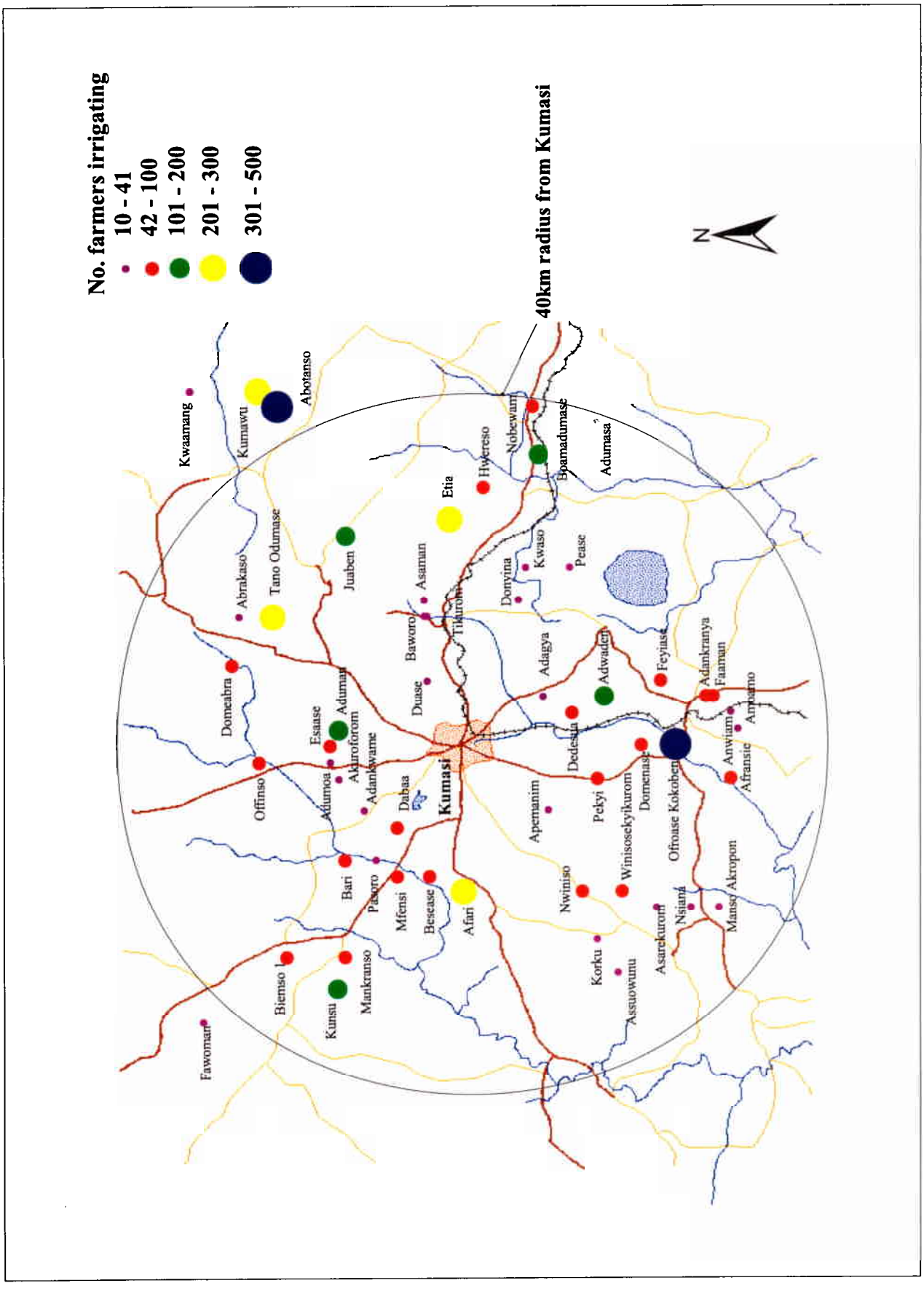


Figure 3 **Number of Farmers Practising Irrigation**

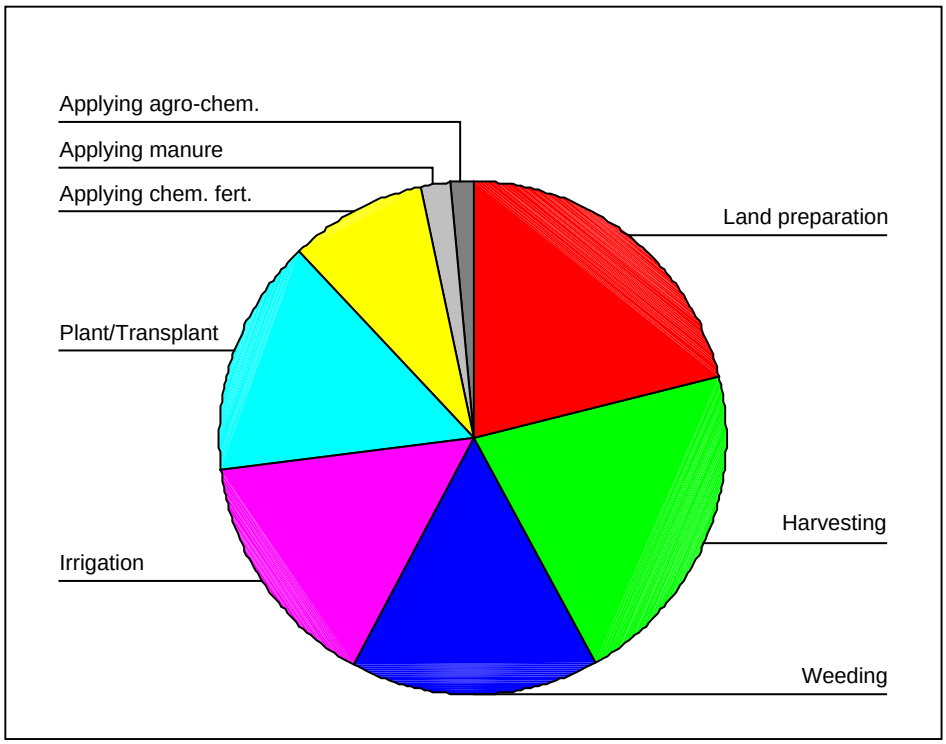


Figure 4 Allocation of Labour Between Different Tasks

Land preparation, which is carried out almost entirely by manual labour, is extremely arduous and 94% of those doing the work are men. It is also the task where most paid labour is engaged. By contrast, 60% of those harvesting crops are women and a third of all female labour is engaged in this task *(Ind. 2.3 (b))*.

The ratio between men, women and children engaged in planting and weeding is very similar. In both cases the tasks are carried out 60% by men, 35% by women and 5% by children. The proportion of children involved in irrigation is much higher. Children do 12% of the irrigation with the rest split almost evenly between men and women.

The three least labour demanding tasks – applying chemical fertiliser, manure and agro-chemicals – are carried out predominantly by unpaid labour. In each task more than 50% is done by men. Women do between 20 to 40% of these tasks and children contribute a maximum of 9% *(Ind. 2.3 (b) and (c))*.

In summary, the division of tasks between men women and children depends upon the nature of the task. Harvesting is the only activity carried out predominantly by women and irrigation is the task where most children are engaged. The tasks where paid labour is most widely used are land preparation, weeding and harvesting.

4.2.1.1 The Use of Labour in Irrigation

Table 1 Number of Farmers Using Different Classes of Labour for Irrigation

	Total number of farmers using this labour	Total number of farmers *paying* this labour	Percent of farmers paying this labour class
Men	328	65	19.8%
Women	301	138	45.8%
Children	113	11	9.7%

Table 2 Number of Labourers Engaged in Irrigation

	Total	No. Paid	(% of total)	No. Unpaid	(% of total)
Men	1352	823	(60.9%)	529	(39.1%)
Women	1463	1063	(72.6%)	400	(27.4%)
Children	384	94	(24.5%)	290	(75.5%)

The total numbers of men and women providing labour for watering are approximately equal – there are 8% more women than men – but a much higher percentage of the women than the men are paid for their labour. This reflects the fact that women are often paid to carry water over a considerable distance from source to field side where the water is temporarily stored in a 200 litre oil drum. (55% of respondents use an oil drum in this way *(Ind. 4.4)*). The farmer himself (unpaid male labour) will then fill a bucket, tin or watering can from the oil drum and apply water to the crop – a task that is regarded as requiring more management skill!

Only 12% of watering labour is provided by children and the majority of those are household members who provide their labour without charge.

Table 3 Average Distance from Source to Field (m) and Labour Class for Manual Water Carrying

	Distance from source (metres)						
	Mains	Stream	Stream pool	Dug out	Stream pool +dugout	Well	Natural Pool
Men paid	18	225	49	126	82		
Men unpaid	99	181	89	228	308	136	92
Women paid	180	206	86	180	546	405	153
Women unpaid	108	180	194	271	110	330	111
Children paid		401	11	158	77		
Children unpaid		254	62	217	128	239	270

Table 3 indicates that there is no obvious correlation between the class of labour employed - male/female; paid/unpaid – and the distance water is carried amongst those reporting manual conveyance (73% of respondents). Half the respondents move water less than 50m from source to field but for each type of source about 10% of users move water well in excess of 200m, resulting in the relatively high average values shown in the table.

4.2.2 The Use of Credit

Approximately one third of the respondents use credit during the production of irrigated vegetables, with most of the credit coming from informal sources. It is notable that more farmers report using credit now, (37%) than when they first started (29%) *(Ind. 2.4 & 2.6)*. This may indicate that they are now more confident of covering their costs and are therefore more willing to use credit. 10% of farmers now obtain credit from middlemen dealing in the crops they grow but only 5% obtained credit from this source when they first started. Moneylenders and family relatives are the two other most common sources of credit.

There is no variation in the use of credit between men and women nor is there evidence of credit being more widely used by farmers with larger holdings. Cross-tabulating the use of credit with irrigation method shows that there is a slight increase above the average use of credit amongst those using pumps – 45% rather than 37%.

4.3 Landholding in Irrigated Vegetable Farming

20% of those questioned farm only irrigated plots. This significant minority of farmers have broken completely with the traditional cropping practices of the region, which centre on rainfed cropping. The other 80% of the respondents hold both irrigated and rainfed land, operating in both the traditional and new agricultural practices *(Ind. 3.1 & 3.2)*.

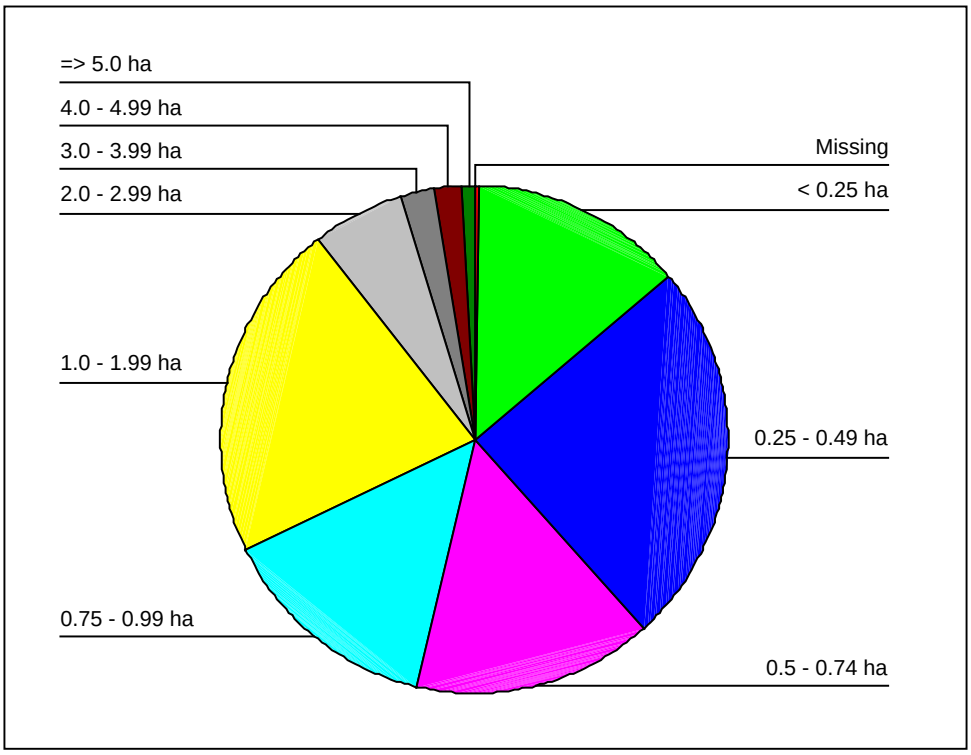


Figure 5 Distribution of Total Irrigated Holding (ha)

The average rainfed holding is 2.4 ha while the average total irrigated holding is only 0.9ha *(Ind. 3.3 & 3.4.1)*. Figure 5 shows the distribution of irrigated plot size amongst the 410 respondents. Whilst there is considerable variation in the area irrigated holdings above 2 ha are uncommon. 20% of farmers reported irrigated farming at two separate locations.

The time that any single plot is cultivated under irrigation varies considerably. 30% of the plots have been cultivated by the farmer questioned for 2 years of less but at the other extreme 50 farmers (12%) reported cultivating the same plot for more than 10 years *(Ind. 3.4.3)*. Discussion with farmers during the initial scoping survey indicated that many of them would move to a new plot once yields were seen to diminish

and the widespread use of short-term, cash tenancies facilitates this mobility. There is widespread use of chemical fertiliser but it is not clear if use of fertiliser is sufficient to maintain high levels of production. The availability of land suited to DSVP is certainly not perceived by farmers to be a factor that limits the activity. The availability of land was ranked as the lowest of six potential constraints, although land without water is of little value and water availability was seen as the third most limiting constraint.

A quarter of the farmers are irrigating on land that floods every year and a further 16% use land that floods "in some years", during the rainy season. The large majority of this land floods for no more than 3 months. Of those farmers whose land does flood, a quarter continue to crop it using raised beds *(Ind. 3.4.4, 3.4.5 and 3.4.6)*.

Farmers may frequently travel from their home to their irrigated plot twice a day to work in the early mornings and late afternoon when it is cooler. Distance to the farm plot is therefore an important factor that may influence productivity. The average distance from house to irrigation site is 2.1 kilometres but over one third of the respondents live less than 1 km from their plot *(Ind.3.4.2)*.

The distance from home to field is particularly important where heavy equipment such as a pump has to be regularly moved between the two. The average distance reported by pump-owners storing their pump in the house is 1.9 km (this does not include the larger number who hire pumps). A few (4) regularly move their pump over 3km.

4.3.1 Tenancy

More than half of the sampled farmers pay cash to rent-in land; the remaining holdings are 28% owned land, 3.2% share tenancy, and the rest in temporary use *(Ind.3.4.9)*. Tenancy contracts do not vary between indigenes and migrants, or between men and women vegetable growers.

Cash renting of land is not a common feature in the indigenous Ghanaian farming systems. The large proportion of cash tenants in this study, therefore, is most striking, and an indication that the customary land tenure regime is being transformed along with advancing land markets. Traditionally, land could be owned, that is held by the village authority or by the family; and as has been found in other areas, land could be operated on share tenancy. Cash rental occurs in situations where the value of land has been appreciated by the landowners. In the case of the irrigated vegetable cultivation, the tenure is short, the most common period is 3 months. The cost of land rental varies considerably with a few farmers reporting rents greater than $US 70/ha/month but 60% of respondents pay less than $US 10/ha/month *(Ind.3.4.10)*.

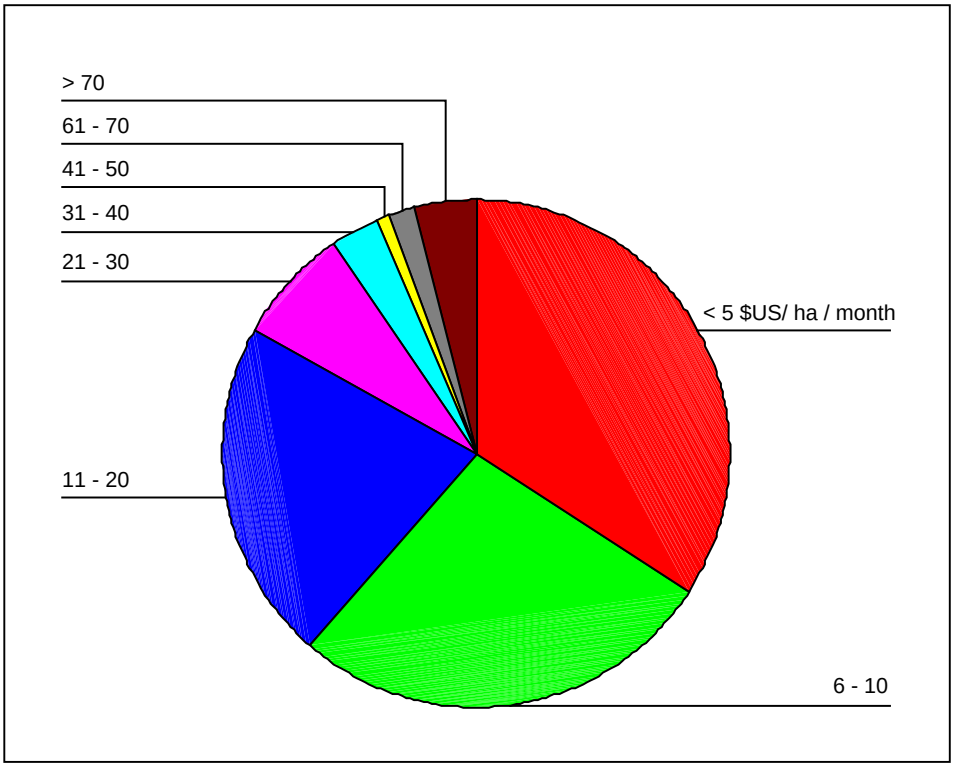


Figure 6 Distribution of Monthly Cash Rental ($US / ha)

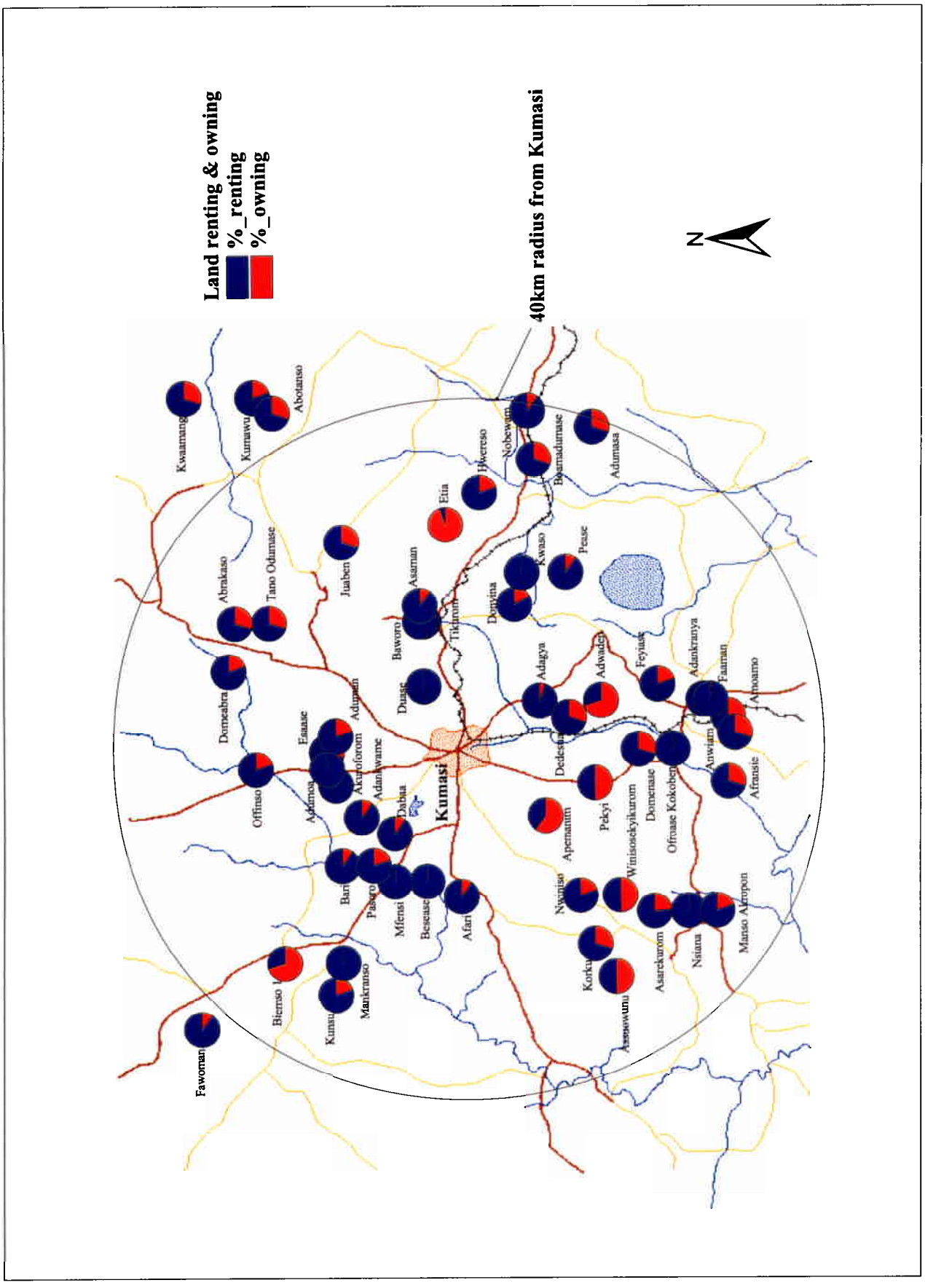


Figure 7 Percentage of Plots Rented and Owned

Figure 7 shows the distribution of cash rental and plot ownership for the individual villages. The incidence of cash rental appears greatest to the NW of Kumasi but cash rental is also widespread in villages to the south. Proximity to Kumasi and the reliability of water supply may be factors that influence the price and extent of cash rental but other factors apart from these must influence the distribution revealed in Figure 7.

4.4 Water Management Practices

4.4.1 The Adequacy of Water Supply

Farmers rank access to water as the greatest physical constraint limiting their production. It is ranked after the major institutional constraints limiting expansion of DSVP, namely the availability of credit and problems of crop marketing *(Ind.8.2)*.

The three questions 4.5, 4.6 and 4.12 evaluate the farmers' perception of the adequacy of the water supply. Responses to the three questions are very consistent, as Table 4 shows:

Table 4 Percentage of Farmers Reporting Water as a Constraint in Response to Different Questions

Question number	Question	Percentage replying
4.5	Does your access to water limit the area that you cultivate in any part of the year?	"Yes", 86%
4.6	Do you think your yield is reduced because you cannot apply enough water to your crop?	"Yes", 82%
4.12	Are you able to apply as much water as you would like to your crops?	"No", 82%

The results show that 80 to 85% of the farmers questioned believe they are constrained by their water supply – they cannot apply as much as they would like, their yield is affected by water shortage or water supply limits the area they cultivate.

Table 5 shows the farmers who do not experience water supply problems listed according to their water conveyance methods. Not surprisingly, the highest percentage of farmers not constrained by water are those with access to the mains supply and those using motorised pumps. Between 40 to 70% of these farmers report no shortage of water. By contrast only about 10% of farmers using manual water conveyance are unconstrained by water. The large majority of this group face a restricted supply either because of the effort required to carry more water or the fear that their source may dry up. Of these two, the issue of physical effort dominates *(Ind.4.5 and 4.13)*.

Table 5 The Water Conveyance Method of Farmers not Reporting a Water Constraint

Water conveyance method	4.5 Area not limited (56 farmers)		4.6 Yield not reduced (75 farmers)		4.12 Can apply as much as I like. (72 farmers)	
	No.	% of method	No.	% of method	No.	% of method
Manual carrying	12	4.0%	36	12.1%	34	11.4%
Motorised pump	29	50.9%	26	45.6%	23	40.4%
Manual + occasional pump	7	24.1%	6	20.7%	9	22.5%
Mains standpipe	7	77.8%	6	66.7%	6	66.7%
Other	1	20%	1	20.0%	1	20.0%

4.4.2 Water Sources

Figure 8 shows the different water sources used for irrigation. 50% of the respondents rely on shallow dugout wells at some time during the season making this by far the most common water source *(Ind. 4.1)*. Many of these farmers use stream pools early in the season and then rely on dugouts as the stream pools dry up. Dugouts are simple, shallow excavations of 1 to 2 m depth and about 1.5 m diameter. They can be temporary or permanent and may be dug adjacent to streams, in the streambed itself or in the irrigated plot if the water table is sufficiently close to the surface. There is no evidence of dugouts ever being strengthened, "improved" or deepened through the use of any form of lining. The absence of lining, coupled with the depth from which it is convenient to raise water manually with a bucket, limits the depth and yield of these dugouts.

None of the farmers using motorised pumps draw water from dugouts, because these unimproved, shallow wells do not give sufficient yield to sustain them. Pump operators draw mainly from the perennial rivers (68%) or from stream pools (21%). Figure 9 shows the 20 villages where motorised pumps are used. Most are adjacent to the larger rivers – the Oda (Dedesua, Adwaden, Feyiase, Ofoase Kokoben,, Afransie) the Ofin (Offinso, Bari and Pasaro) and the Anunu (Nobewam) – but smaller streams and stream pools support at least 16 pumps in villages such as Winisosekyikurom and Adumasa. Not all farmers with access to a perennial river source are able to exploit it with a motorised pump (hired or owned). 40% of those drawing from such a river rely upon manual carrying with a bucket, watering can or similar container.

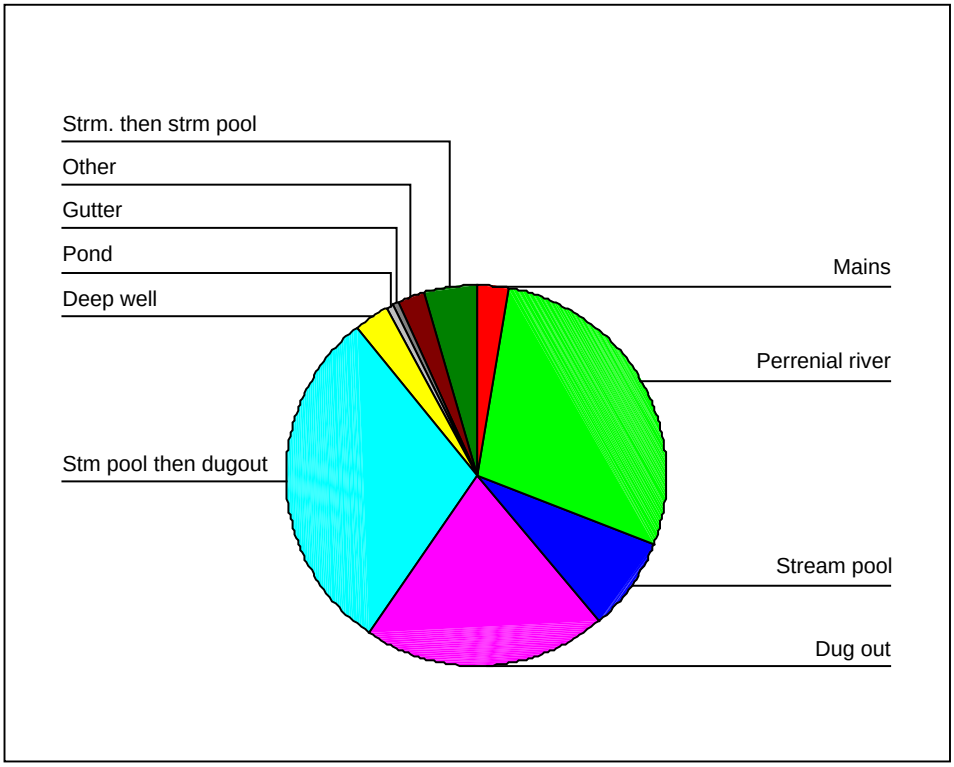


Figure 8 Water Sources Used for Irrigation

Perennial and ephemeral rivers and shallow groundwater provide water for 91% of respondents. A small number (2.7%), with access to the pressurised domestic supply system of Kumasi use this for irrigation and a similar number draw water manually from deep wells.

4.4.3 Conveyance Distance

The distance that farmers convey water from source to field varies greatly between individuals. For every source identified – with the exception of the few farmers drawing water from urban gutters – 40 to 60% of

respondents, moved water less than 50m from source to field. However, for each source there are a significant number of farmers obtaining water from a source more than 500m away so that the overall average distance that water is conveyed is about 200m *(Ind. 4.2)*. The physical work and effort involved in lifting and carrying water over uneven and rough ground is one of the striking features of this study. It is not surprising that almost 70% of the respondents refer to the effort required to carry water in explaining how access to water limits their cultivated area.

From these initial data there appears to be considerable potential for demonstrating and evaluating the farmer acceptability of low cost water lifting devices such as treadle pumps. These pumps might reduce the degree of drudgery and effort currently experienced by those carrying water and considerably improve the productivity of irrigation labour. Unlike motorised pumps, they could often be used in combination with shallow dugouts – one of the most common sources of water.

4.4.4 Conveyance and Field Application Methods

There is no evidence of farmers using open channels and gravity to convey water from source to field or to spread the water between plants. All farmers use some form of overhead application. Those using manual labour to carry water either directly to the plant or to a field-side oil drum apply the water with watering cans or with buckets and perforated tins. Those using a pump normally use 50mm uPVC pipes to convey the water from the pump to a position within the field and connect a short length of 50mm layflat hose to the final pipe length. A worker then stands and sprays water from the hose-end, trying to spread the water uniformly and prevent crop and soil damage from the impact of the jet.

The use of manual, overhead irrigation where water is lifted and carried manually from the source seems entirely appropriate. The method avoids the need for the levelling or grading of beds and conveyance losses in open channels are avoided. Workers can adjust the volume applied to different crops and different beds and water use efficiency is likely to be high. By contrast, the wild spraying of water from a 50mm layflat hose is a very poor way of applying water. Observation in the field confirms that the application uniformity is very low, resulting in very uneven crop stands. The initial unevenness of application is compounded when water runs off the field surface and ponds in natural depressions. This frequently occurs because the application rate exceeds the infiltration rate. When plants are small, the risk of damaging seedlings with the water jet is high. To try and minimise this risk operators cut back the operating speed of the pump which results in the pumps running very inefficiently.

While farmers relying on manual water carrying are constrained in the volume of water they can apply because of the physical effort involved farmers hiring pumps can face a different constraint. Where the pump owner makes a fixed charge to each farmer irrespective of the time for which the pump is used it is in the owner's interest to move quickly between as many farmers as possible – a situation exacerbated by the small number of pumps that are available for hire. Those hiring report having to wait for a pump to be available and it is common for the owner to come and operate the pump himself. The owner is therefore interested in getting some water onto the irrigated crop as quickly as possible before moving on to another farm. Uniform and adequate irrigation may take second place to the need for speed.

The frequency of irrigation varies according to the crop, its stage of development and the weather but is also influenced by the irrigation method. Nurseries and young seedlings are generally irrigated on a daily or twice daily basis. Even when a crop is established, farmers who water manually may continue to irrigate on a daily basis or every three days but farmers using pumps extend the irrigation frequency to 5 to 7 days *(Ind. 6.1 (e))*. Crops widely perceived to require daily irrigation when manually irrigated are:

Carrot	Cucumber
Green bean	Lettuce
Onion	Spring onion
Water melon	

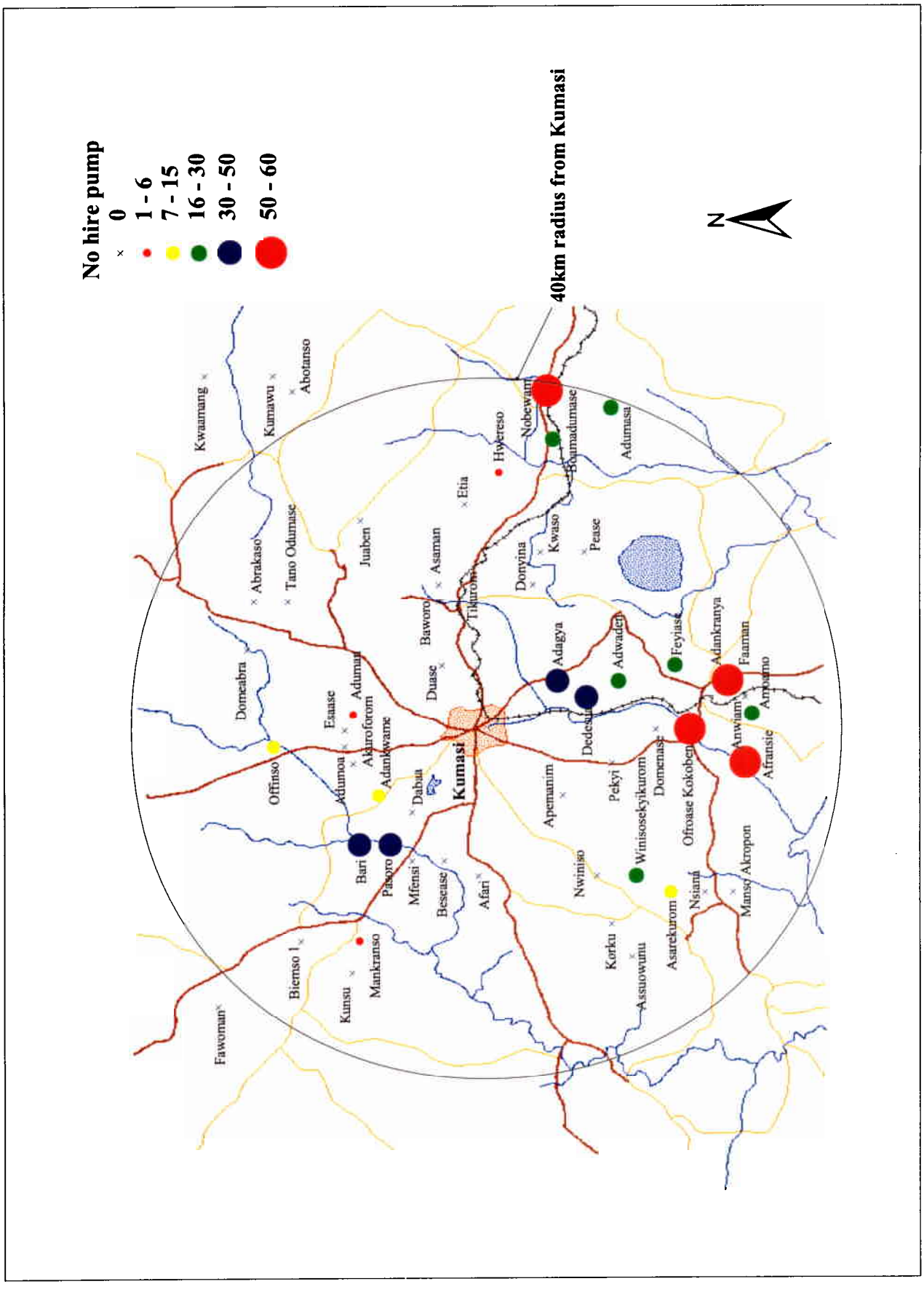


Figure 9 Number of Irrigators Hiring Pumps

4.4.5 Improved Practices for Pump Irrigators

Two potential interventions, which might lead to improved productivity of water, labour and fuel, amongst those using pumps for irrigation, are:

1. Encourage the use of surface channels to direct water to graded flat or ridged beds. Water would be pumped to one or two high points on the plot and distributed in earth channels from there. This would require considerable initial investment of labour to layout and construct the network of beds and channels, particularly on irregular, uneven ground but once complete, improved water distribution would be possible. For many farmers who are renting land on a short term basis such investment in land improvement is unlikely to be attractive.

2. Promote the use of simple, portable draghose sprinkler systems in combination with the pumps. A four sprinkler system, suited for use with smaller 2kw (2½ hp) pumps, may cost about US$750, including the cost of the pump, or US$300 where the pump is an existing, sunk cost. This might be targeted particularly towards the small number of farmers (22, or just 5% of respondents) owning and hiring out a pump. By hiring the pump and sprinkler system they could recoup their investment cost and those hiring the equipment would benefit from improved application uniformity and reduced labour inputs to oversee irrigation. Those making occasional or regular use of pumps make up 24% of respondents. The current use of sprinklers is very low – only 3 farmers reported sprinklers amongst their inventory of equipment and of these only one hired the sprinklers to another farmer.

Both of these interventions appear to offer technical benefits but study and evaluation would be required, in collaboration with farmers, to assess the wider benefits and costs associated with them, particularly in view of the need for rapid, albeit uneven, irrigation when pumps are hired. Both interventions would require effective practical demonstration and training in order for farmers to adopt them effectively.

4.4.6 Payment for Water

The costs reported by farmers in obtaining irrigation water vary considerably within any given method and between methods.[1]

199 farmers (48% of the total sample) pay labourers to carry water *(Ind. 4.11)*. (Of these, 9 do not report the term of payment and therefore do not appear in table 4.11 of results in Appendix 3). 50% of farmers paying for water carrying pay per barrel, 37% pay per day and the remaining 13% pay per month. There is no correlation between the terms of payment and irrigated plot size.

Appendix 4 sets out a series of assumptions and calculations used to allow comparison of the seasonal cost of water when the payment term varies. Table 6 shows the results of those calculations.

Table 6 Summary of Seasonal Water Costs

Irrigation method & term of payment	Approximate seasonal cost $US
Manual carrying:	
Monthly payment	62
Daily payment	130
Payment per barrel	480
Motorised pumping	
Pump owners	120
Pump hirers	300

[1] All prices quoted in this report were converted from the reported Cedi values to $US at the interbank conversion rate of 2360 Cedi = $US 1.00 which was the rate applying on January 1st 1999.

The wide variation about the average values and the various assumptions made in order to allow comparison of the different terms of payment mean that these figures are no more than guide values. Given the sensitivity of the figures to changes in the assumed irrigation frequencies or season duration it may be argued that the price for water paid by pump owners, and those paying labourers on a daily basis are equal while those hiring pumps pay approximately 2 ½ times more. Those paying for water per barrel pay almost 4 times that paid by day labour or by pump owners.

This initial analysis suggests that where there is access to a reliable water supply and where a farmer can raise the capital required to purchase a pump the seasonal cost of operating the pump is comparable with that of paying labour to carry water manually. However, the volume of water provided by the pump will far exceed that lifted manually and where the owner chooses the pump can be hired out to generate additional income.

4.4.7 Adequacy of Irrigation

Using the information from those paying per barrel some initial calculations can be made of irrigation applications and likely adequacy.

a) Crop water demand:

Assume a single crop is grown and irrigated over a 100 day period

Assume the average daily crop water requirement is 1.5 mm

Therefore the total depth required = 150mm

b) Volume of water supplied:

12 barrels per day on average over the 100 day irrigation season with a 3 day irrigation frequency:

(100 / 3) x 12 = 400 barrels

400 x 0.2m^3 = 80 m^3

c) Area irrigated:

Applying a depth of 150mm, and assuming no losses, the area irrigated is:

80 / 0.15 = 530 m^2

No farmer reported irrigating a plot of less than 500m^2 and only 18 farmers estimated their plot to be less than 2000m^2.

There are three possible conclusions that can be drawn from this:

1. Crops are severely under-supplied with water, which is in keeping with the farmers' own perceptions.
2. Farmers over-estimate the area of their irrigated plots.
3. Only a fraction of total plot – say 50 to 65% - is actually cultivated and irrigated, but even this only raises the gross plot area that could be adequately watered to between 800 and 1060 m^2.

Further detailed field investigations are required to obtain more information on water management and the true degree of under-supply.

4.4.8 Water Quality

A quarter of those questioned said they would not drink the water they used for irrigation, mainly because they believed the water to be polluted or "infected with worms or bacteria". However, there is no evidence that the farmers associate poor water quality with a particular type of water source, as Table 7 demonstrates.

Table 7 Farmer Perceptions of Water Quality According to Source Type

	Would You drink the water?			
	Number		Percent	
Source Type	**Yes**	**No**	**Yes**	**No**
Piped mains supply	11	0	3.6	0
Perennial river	84	31	27.4	30.7
Stream then stream pool	16	2	5.2	2.0
Stream pool	23	9	7.5	8.9
Dug out	58	26	18.9	25.7
Stream pool then dug out	95	27	30.9	26.7
Deep well	12	0	3.9	0
Gutter	0	3	0	3.0
other	7	2	2.3	2.0
Natural Pond	1	1	0.3	1.0
TOTAL	307	101	100.0	100.0

Concern over water quality (reflected in whether or not farmers would drink the water) is raised as much over water from dug outs as over water from the perennial streams. Although 25% of respondents believed the water to be unsafe to drink only 6% said that the water quality influenced their choice of crops and the largest part of this group draws water from dug outs. Thus, the concern of this research team and others over the high levels of organic pollution in the Subin and Oda rivers draining Kumasi and the perception that dugouts offer a cleaner water supply is not borne out in the views of the farmers.

4.5 Types of Equipment Used

The predominant types of equipment used by farmers in DSVP are small hand-tools. Every farmer appears to own at least a machete and 95% of respondents have a hoe. Apart from these two simple implements no other equipment is common to all respondents. A bucket, for example, which might be considered a basic and widely owned piece of equipment is only owned by 56% of respondents, but they are more widespread than watering-cans that are only owned by 22% of respondents *(Ind.5.1)*.

Some of the low value items such as mattocks, hoes and surprisingly watering cans and water hoses are commonly left in the field but other items such as machetes, baskets and buckets that may be more prone to theft are more often stored in the home and carried to the field when required. High value equipment, specifically motorised sprayers, motorised water pumps and knapsack sprayers, are almost always stored in the home though a few exceptions to this rule are recorded.

The three high-value pieces of equipment, motorised sprayers, motorised water pumps and knapsack sprayers, stand out in the list of equipment as the most frequently hired equipment types. The percentage of respondents with access to these high-value items through ownership hiring or borrowing, is shown in Table 8.

Table 8 Percentage of Respondents with Access to Motorised and Knapsack Sprayers and Water Pumps

Equipment	Cost new (late 1999)	Mean hire charge $US/day	% of farmers owning	% of farmers hiring	% of farmers borrowing	% of farmers with access
Knapsack sprayer	55	1.3	15.4	5.4	10.5	31.3
Motorised sprayer	350	2.0	10.2	23.7	3.9	37.8
Motorised water Pump	420	8.1	5.1	18.0	0.5	23.6

Knapsack sprayers are the most widely owned of these high value items and are also the most widely borrowed item after barrels. Motorised sprayers are only owned by 10% of the sample but almost a quarter of farmers interviewed (23.7%) hire these sprayers. Pumps are owned by an even smaller percentage of farmers (5%) but again there is significant hiring of pumps such that overall almost a quarter of the farmers interviewed have access to pumps. These three items account for 71% of all equipment hire recorded *(Ind.5.3)*. The relatively widespread nature of equipment hire confirms that DSVP is a remunerative activity, well established in the cash economy of the region. It is not unreasonable to expect that if a new technology such as manual treadle pumps for water lifting was introduced then there could be significant opportunities for those buying the pumps to recoup their investment through hiring.

4.6 Cropping Information

Many farmers aim to harvest two irrigated crops during the dry season between October and April. First planting is often carried out in October taking advantage of the short rains in this month to help germinate and establish the crop. Where possible harvesting is then timed to coincide with peak demand over the Christmas and New Year period. Farmers with a reliable water supply will then plant again in January with a view to harvesting around the Easter period.

Table 9 Number of Farmers Cultivating Different Crops and the Average and Maximum Plot Areas

Crop	Total area (ha)	No of Farmers	Average crop area (ha)	Max crop area (ha)	No. of stands > 2 ha
Tomato	99.29	193	0.51	3.24	4
Garden egg	84.06	177	0.47	4.86	5
Okra	77.70	153	0.51	7.28	6
Hot pepper	55.61	114	0.49	6.07	1
Cabbage	18.45	53	0.35	1.21	0
Cucumber	4.66	20	0.23	0.81	0
Green pepper	3.51	17	0.21	0.40	0
Lettuce	16.44	16	1.03	11.74	1
Carrot	2.89	12	0.24	0.61	0
Ayoyo	5.06	10	0.51	2.02	1
Green bean	1.67	9	0.19	0.40	0
Onions	2.02	7	0.29	1.21	0
Spring onion	1.13	6	0.19	0.40	0
Sulve	0.30	6	0.15	0.20	0
Water melon	4.05	6	0.81	2.83	1

The four most widely irrigated crops are tomato, garden egg, okra and hot pepper. Together these four crops account for 84% of the total recorded crop area of 376 ha. Tomato is the most widely grown crop, grown by 47% of respondents.

These four crops, with the surprising addition of lettuce, are grown as the largest single stands as Table 9 demonstrates.

Figure 10 shows the top four crops in each village ranked according to area. The widespread distribution and popularity of the fruit vegetables – tomatoes, garden egg, okra and hot pepper – is clearly shown. The key in Figure 9 lists the other crops ranked by some villages in their "top four". The distribution of the green and root vegetables - cabbage, carrot, cucumber, lettuce, green pepper and onion - is shown in Figures 11 – 16. Cabbage is widely distributed across the survey area – only 8 sites do *not* report any farmers growing cabbage. The other root and green vegetables are more restricted in their distribution but their spread has little obvious correlation with location relative to the urban centre of Kumasi. There is strong overlap between villages growing carrots, cucumber and lettuce, possibly suggesting that these are locations where farmers have acquired the knowledge to cultivate these more "exotic" vegetables.

Figure 14 shows a concentration of lettuce producers close to the centre of Kumasi, consistent with the fact that lettuce cannot easily be stored or transported over large distances. The sites more distant from Kumasi where lettuce is grown tend to lie close to the major roads serving the city. The distribution of growers cultivating carrot, cucumber, green pepper and onion does not follow this geographic trend.

The total income for each crop was calculated by summing the product of yield and the corresponding unit value reported by each farmer. This was then divided by the total reported area to give an estimate of gross income per hectare – before deduction of fixed and variable costs – for each crop enterprise. The results are shown in Table 10.

Table 10 Crop Areas and Gross Incomes Sorted by Gross Income per Hectare

Crop	Total Area	Total Income ($US)	$US / ha
Cabbage	18.45	83,954.0	4,551.3
Carrot	2.89	4,670.9	1,614.2
Garden Egg	84.06	135,017.8	1,606.2
Cucumber	4.66	7,168.9	1,539.0
Tomato	99.29	133,323.7	1,342.7
Hot Pepper	55.61	69,049.1	1,241.7
Okra	77.70	94,680.9	1,218.5
Green Bean	1.67	1,585.1	948.4
Onion	2.02	1,812.8	895.9
Watermelon	4.05	3,388.4	837.3
Green Pepper	3.51	2,606.7	742.9
Ayoyo	5.06	1,061.4	209.8
Lettuce	16.44	2,704.6	164.5
Spring Onion	1.13	173.7	153.3
Total	376.54	541,198	

Based on the sample size of 410 farmers the average gross income per farmer is $US 1,320. Using the estimate of 12,700 farmers within the study area (See Section 4.1) the total value of irrigated crops grown and marketed is in the order of $US 16 million.

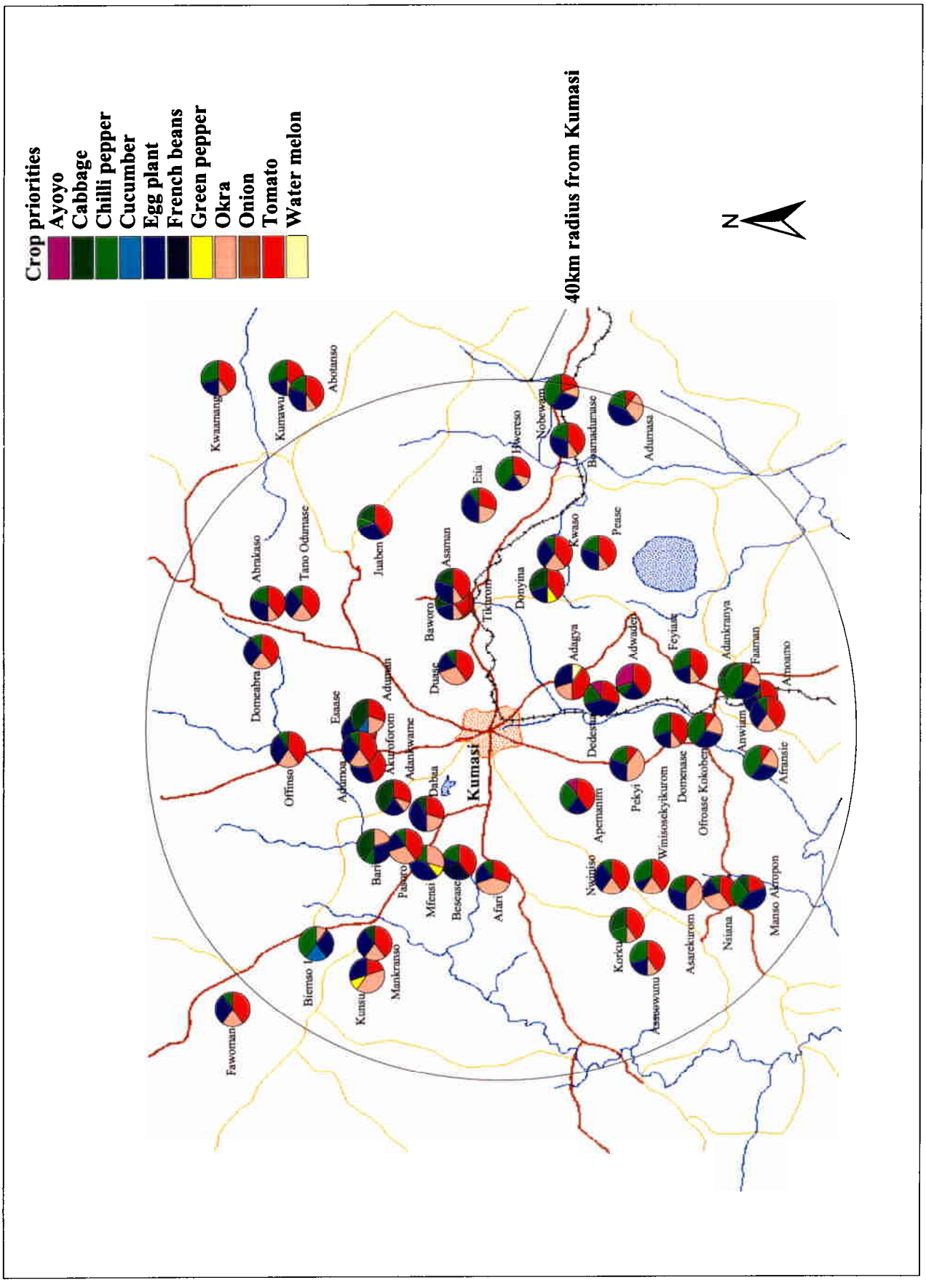


Figure 10 Most Popular Crops

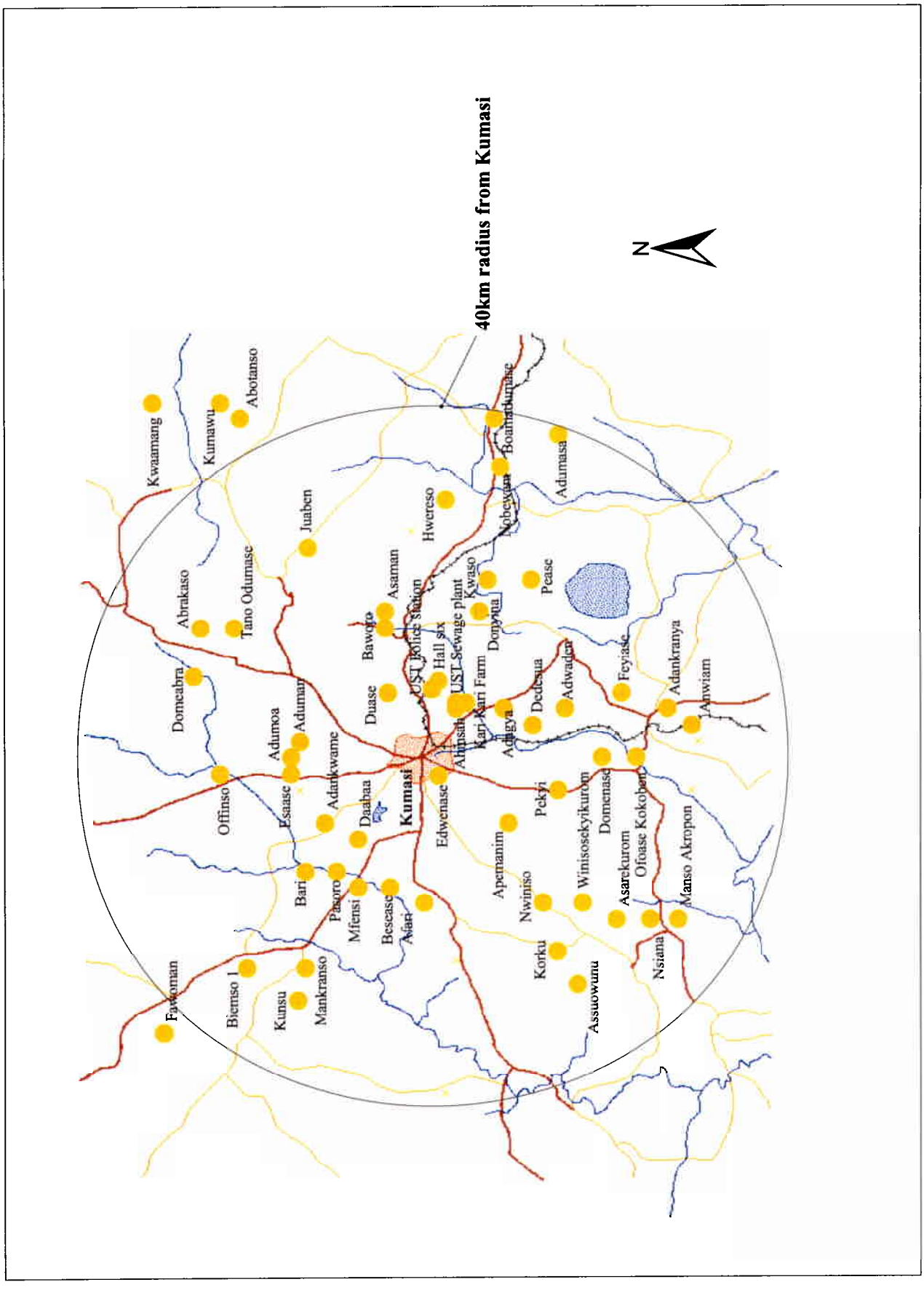


Figure 11 Sites Growing Cabbage

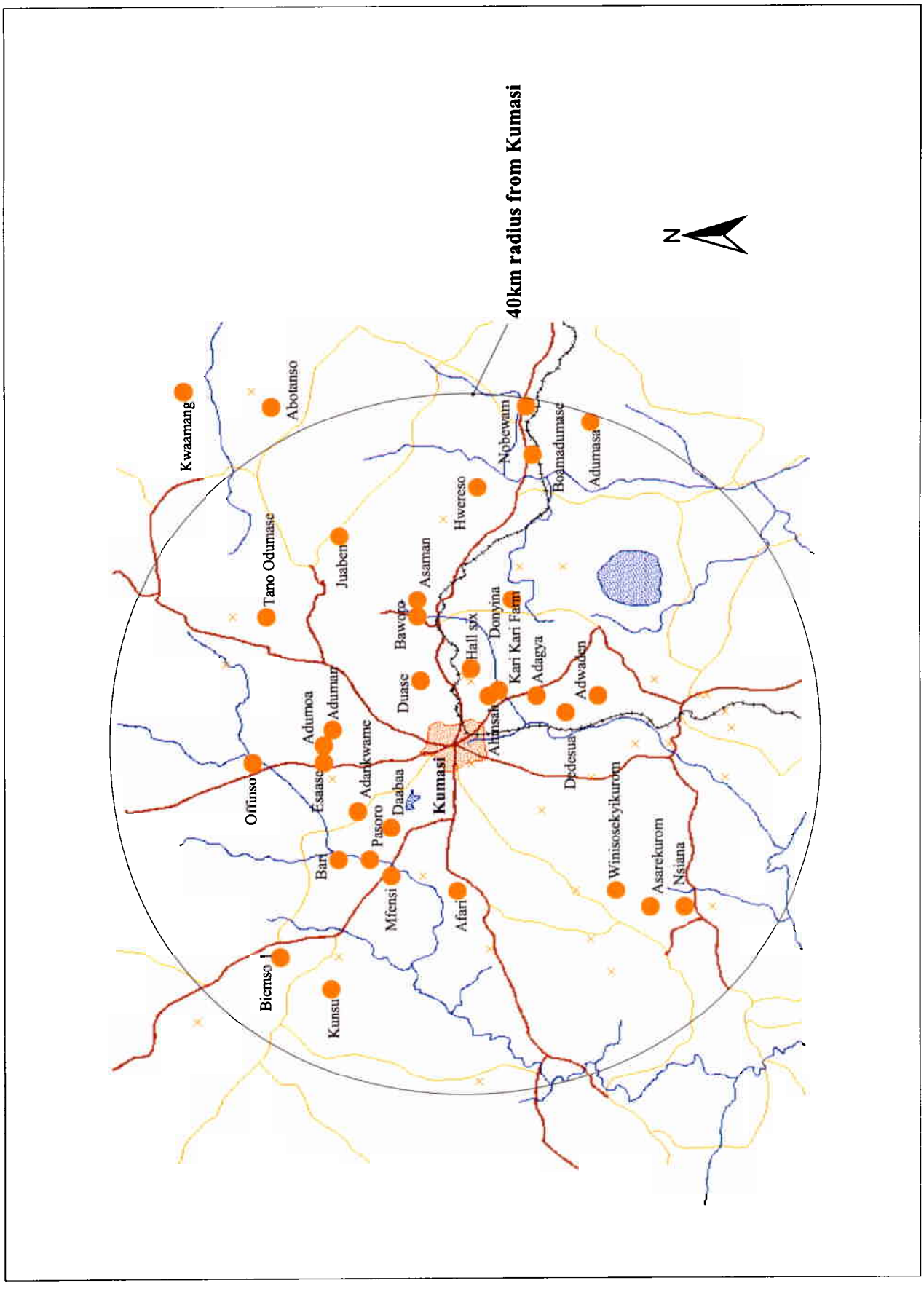


Figure 12 Sites Growing Carrots

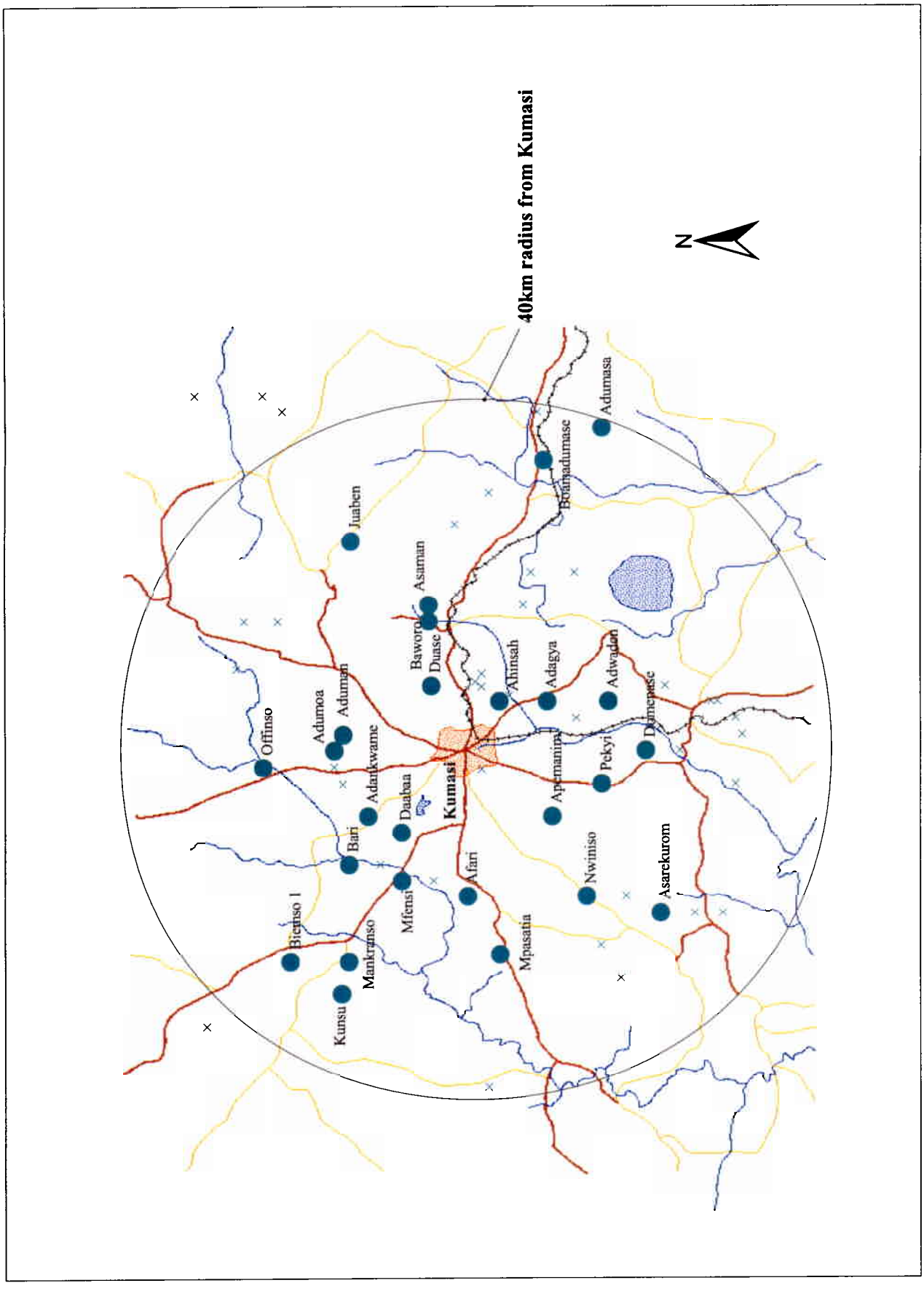


Figure 13 Sites Growing Cucumber

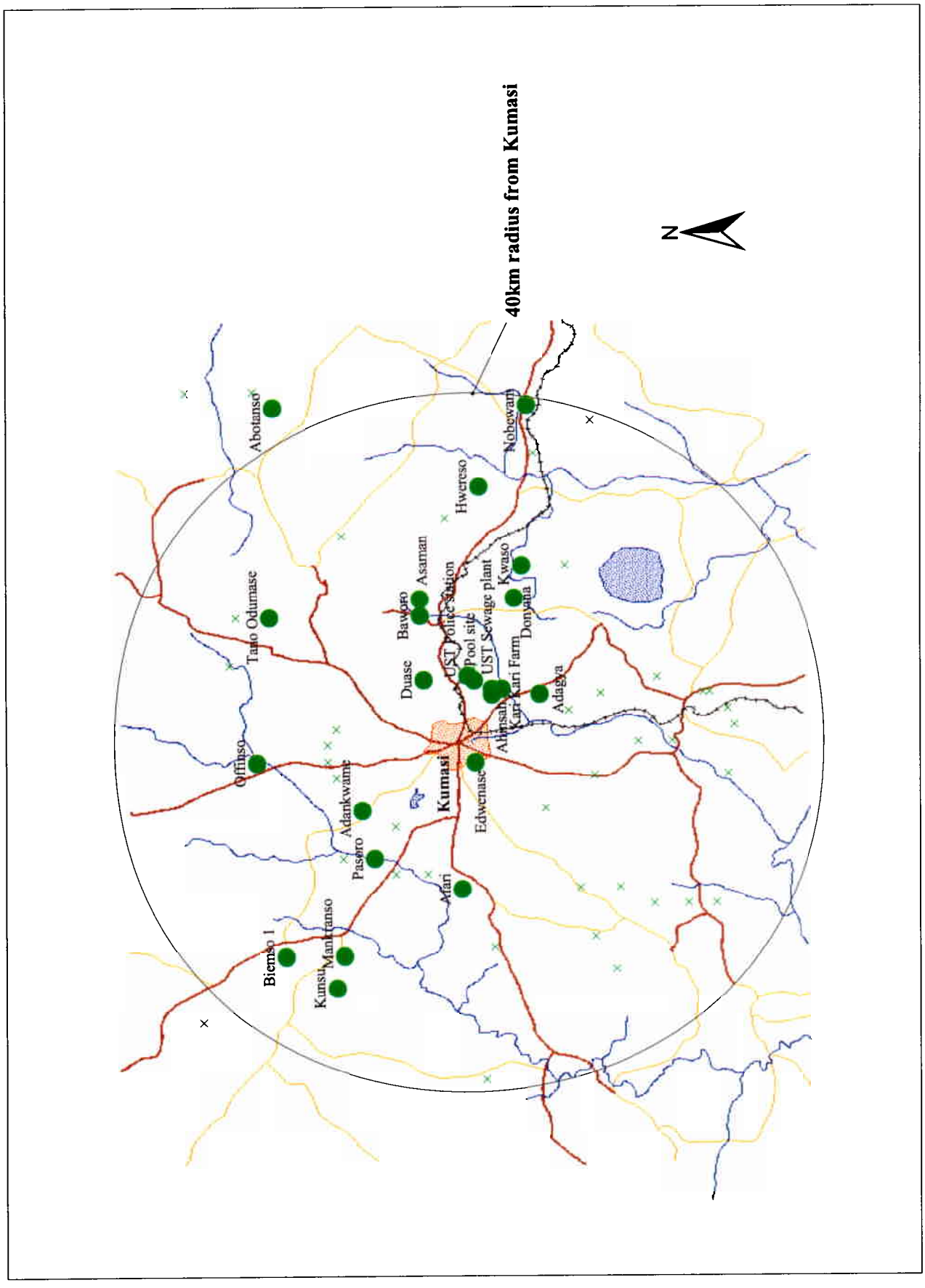


Figure 14 Sites Growing Lettuces

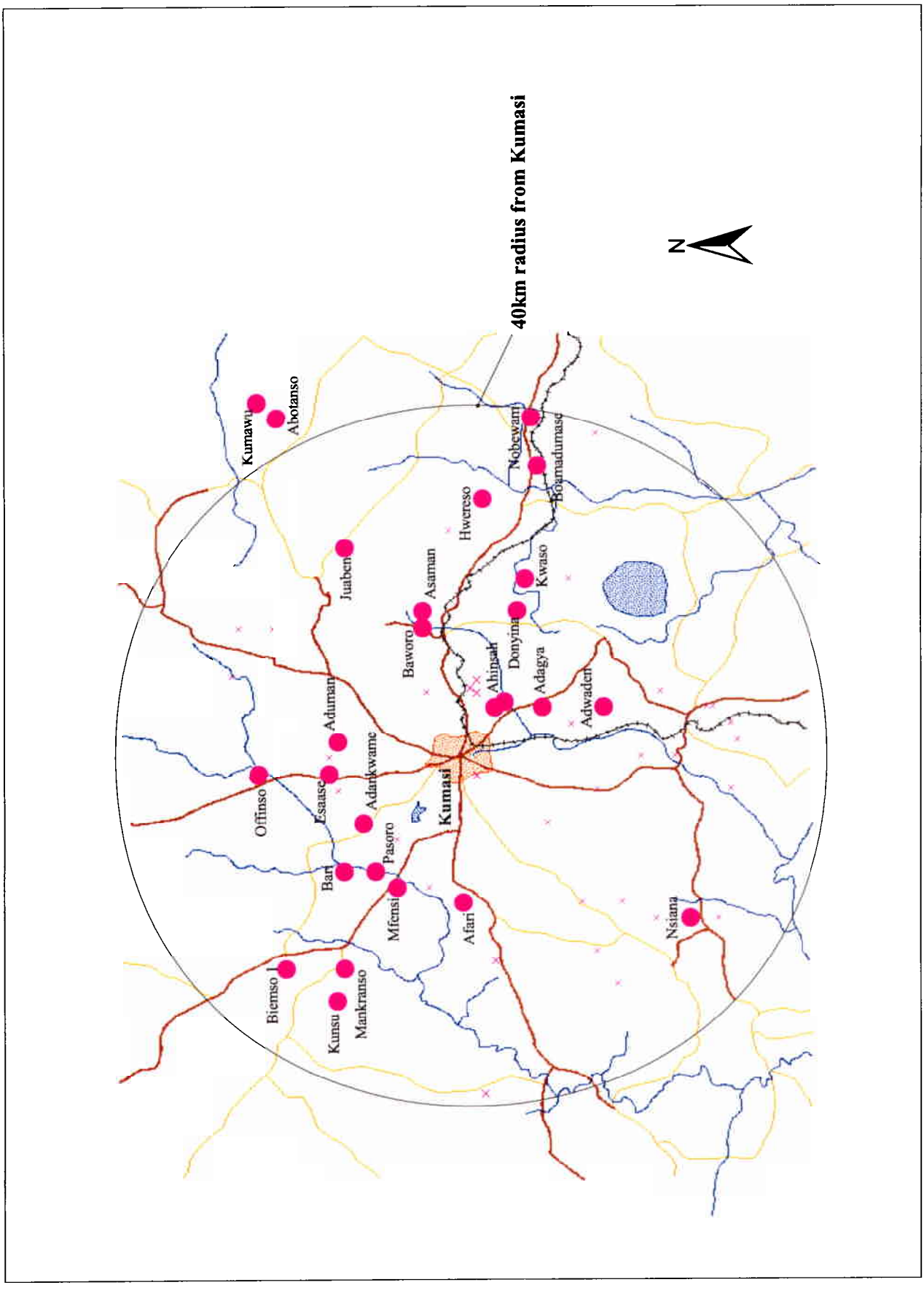


Figure 15 Sites Growing Green Peppers

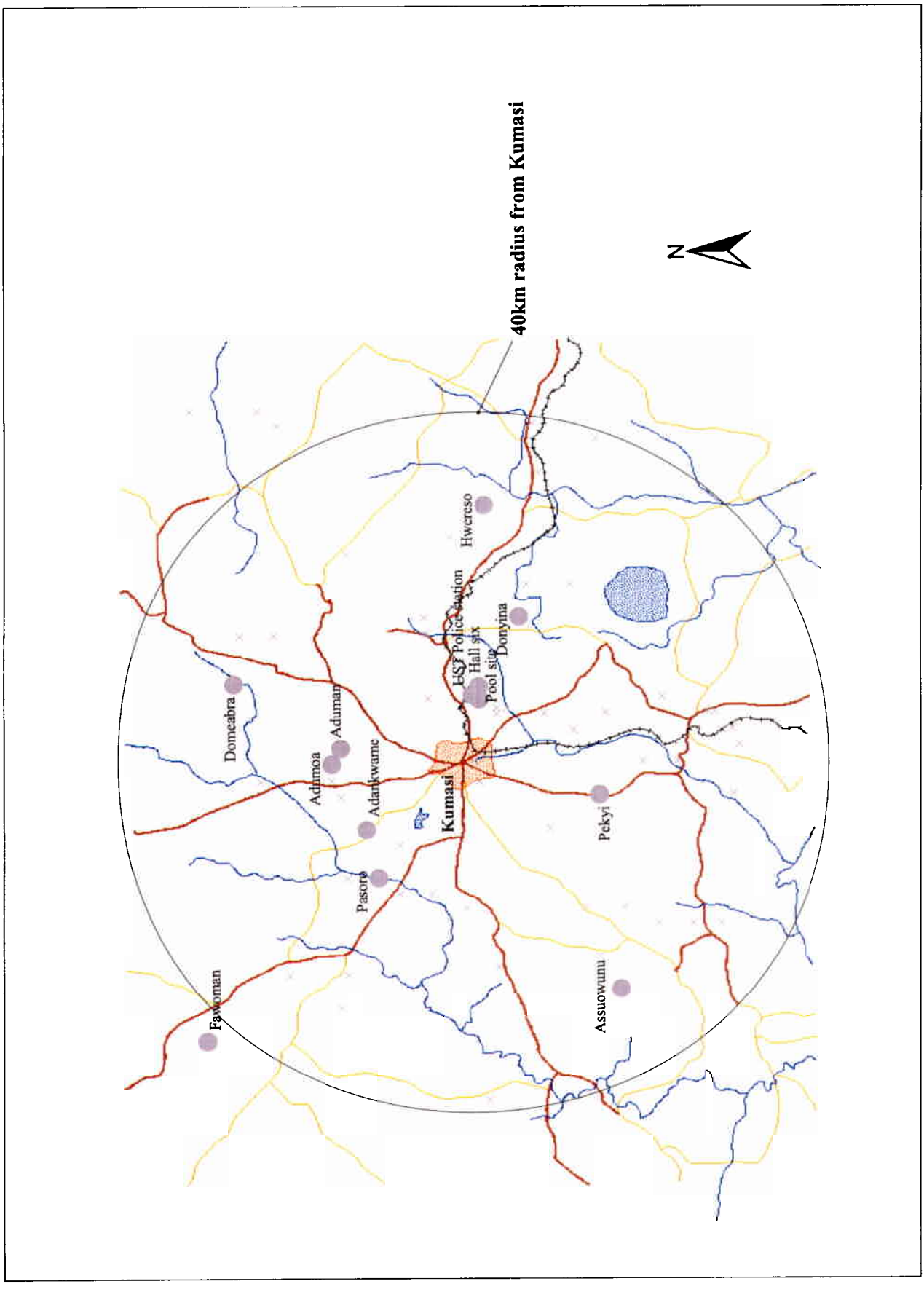


Figure 16 Sites Growing Onion

The gross income per hectare of cabbage is surprisingly high, being almost three times greater than the next crop in the list. However, farmers report that the production costs of cabbage are particularly high due to the high cost of seed and fungicides and its higher water requirement. It also has a relatively long growing season and hence a longer period before any income is generated. This can be contrasted with lettuce, which although having an apparently very low gross income per hectare, is a fast growing and maturing crop which provides a rapid cash return.

Both cucumber and carrot return some of the highest gross incomes per hectare but are grown on a smaller scale than the fruit vegetables. The information on levels of inputs used, *(Ind. 6.2)* indicates that these crops have some of the highest levels of input use but more detailed studies of crop budgets will need to be completed to determine the gross margins of these crops and permit a better evaluation of profitability. The other crops returning a high gross income per hectare are the more widely grown crops, as would be expected.

Figure 17 shows the distribution of the average gross income based on the average income of the six respondents interviewed in each village. The data suggest that there is an east/west divide in the distribution of income, with villages to the west of Kumasi securing incomes greater than $US 1,000 / ha while those to the east have incomes below this. No clear explanation for this trend can be put forward at this time. There is no clear evidence, based on Figure 17, of consistently higher or lower incomes in villages closer to Kumasi.

Reliance on commercial seed and agro-chemicals is generally widespread but shows some variation between crops. There is heavy reliance on insecticides, fungicides and inorganic fertiliser but the use of herbicides is much more restricted. Use of commercial seed is lowest for tomatoes and hot pepper – 44% and 33% respectively *(Ind. 6.2)*.

The use of organic manure is almost entirely confined to those farmers farming in close proximity to poultry farmers where poultry manure is readily available. As poultry farms are in turn restricted to an area within 5 to 10 km from the urban centre this is the only area where manure is used. Crops with the highest use of manure are lettuce, spring onion and onion.

It is striking that only 10% of respondents report having received any formal training in vegetable production *(Ind. 6.3)*. The large majority of growers are self taught, relying on knowledge, of uncertain quality, passed from farmer to farmer and that which is brought in by farmers returning from work in neighbouring countries. Farmers also obtain some information from traders selling seed and agro-chemicals.

4.7 Crop Marketing

The single most common means of produce marketing is by growers taking their own produce to a market. Almost 90% of the respondents sell some or all of their produce in this way, the principal market destination being Kumasi. Very few growers take their own produce to other market outlets.

Selling directly to traders who visit the field is practised by 55% of growers, showing that a relatively sophisticated marketing mechanism for vegetable produce has grown up in the region, with traders even coming from neighbouring countries. 40% of traders come from Kumasi, 20% from Accra and smaller numbers from Obuasi, Takoradi and other local centres *(Ind.7.1 (a))*.

Selling of some produce from the field to local consumers is reported by 34% of respondents but only one respondent reported this to be their sole method of marketing.

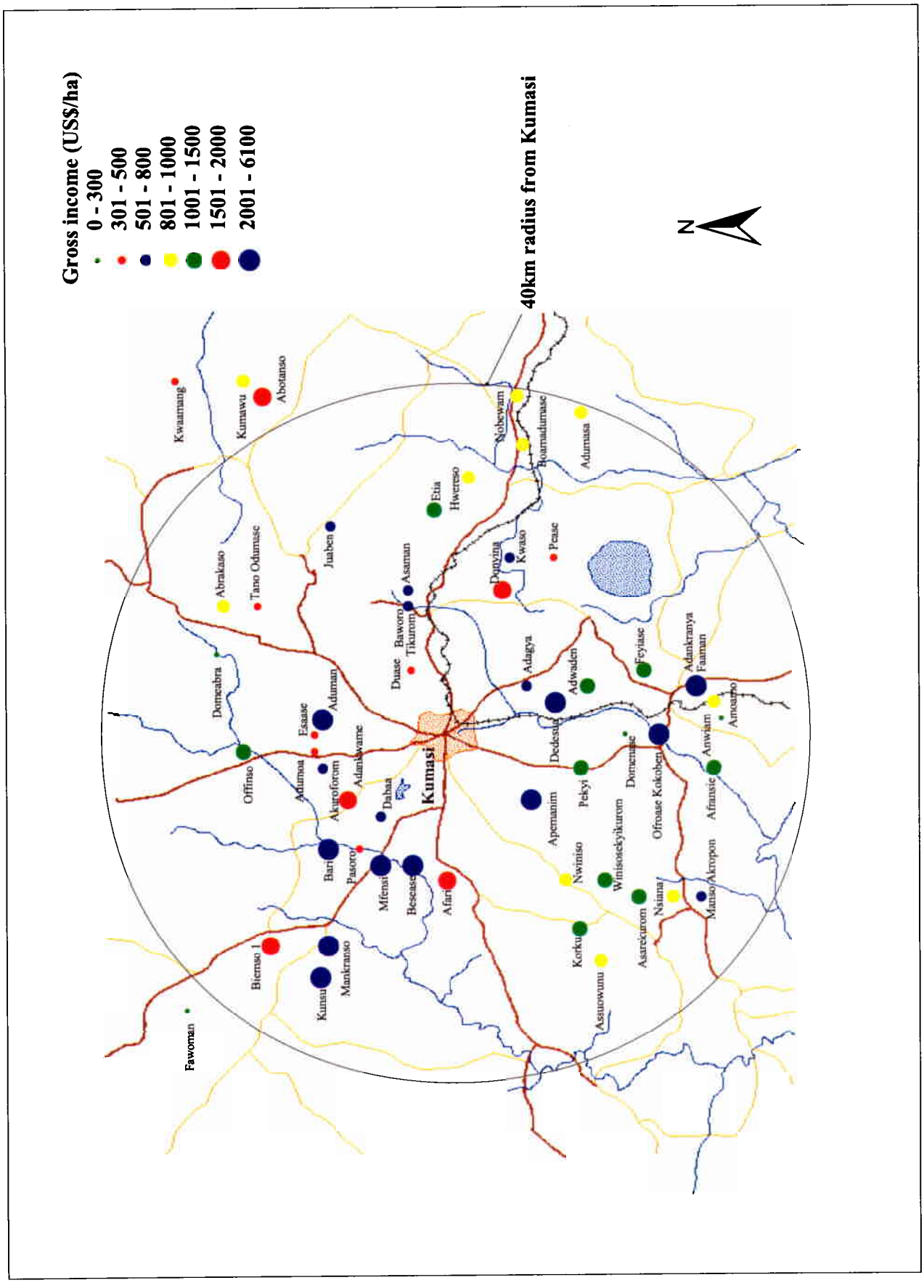


Figure 17 Distribution of Average Gross Income

Formal farmer co-operatives for marketing of produce are not widespread. Just 3 farmers, or 0.7 % of the sample were members of such a co-op. Informal co-operation for marketing is more widely practised with 10% of respondents reporting membership of such a group. Apart from these very small numbers, produce marketing is carried out on an individual basis.

4.8 Farmers' Conception of Constraints

For the majority of respondents DSVP is their primary source of cash income and therefore a very important activity. Although respondents can readily identify constraints that limit their production almost 80% said they had 'plans' to expand their irrigation activity within the next year *(Ind. 8.1)*. Even if many of those 'plans' are no more than wishful thinking, the evidence is that farmers see dry season irrigation as having a productive future and they wish to continue their involvement in this sector. Despite this there are constraints that limit farmers' opportunity to expand.

Table 11 Constraints to Expanding Irrigated Production Ranked by Farmers by Pair-Wise Ranking

Constraint	Ranking Score
Credit	28.3 %
Crop marketing	19.2 %
Water supply	18.4 %
Availability of inputs	17.8 %
Availability of Labour	10.5 %
Availability of Land	5.8 %

Using pair-wise ranking respondents ranked six potential constraints as shown in Table 11. The percentage values indicate the contribution of that factor to the overall perception of constraint registered by the respondents.

The major constraint, as perceived by all farmers, is the lack of credit. This single constraint is ranked well above any of the others. Issues of marketing, water supply and the availability of inputs each received very similar ranking. Although most growers are able to market into the large urban centre of Kumasi or other major cities prices fluctuate sharply and farmers are at the mercy of either the market queens or the traders to whom they sell. These problems, together with the absence of crop storage or processing facilities and the risk of short term gluts explain why marketing is ranked as the second greatest constraint.

Concerning the physical factors of production the problem of securing a reliable and adequate water supply for irrigation is ranked as the greatest constraint but obtaining other inputs – seed and agro-chemicals – is also ranked as a serious constraint. It is striking that access to labour and land are ranked as much less constraining than these other factors.

5. SUMMARY OF PRINCIPAL FINDINGS

5.1 The Extent and Role of Informal Irrigation

- The areal extent of DSVP can be estimated from the information gathered in this survey. The initial scoping survey easily identified 100 villages within a 40km radius of Kumasi where DSVP is practised. Community level interviews at 63 of those villages gave an estimate of 8,000 households involved, with an average household of 7 members and an average plot size of 0.9 ha. Scaling up to the 100 villages identified the data indicate that there are at least 12,700 households, representing 89,000 individuals, in the study area cultivating roughly 11,500 ha.

- This large area of informal irrigation within 40km of Kumasi, must be contrasted with the 6,400 ha under formal irrigation, in all of Ghana, reported in FAO's statistics (FAO, 1995). Kumasi alone supports an area of informal irrigation almost twice that of all formal irrigation in the country and further areas of informal irrigation are known to exist around Accra and Takoradi. This area of informal irrigation, coupled with the fact that the number of farmers engaged in DSVP has increased markedly over the last 10 years, indicates that informal DSVP is an important activity, contributing to the livelihoods of many peri-urban communities. However, there appears to be little recognition or support for this sector coming from regional or national policy makers.

- Almost all irrigation is occurring in the urban fringe and in the peri-urban zone - an area influenced by the presence of the urban centre but still rural or semi-rural in appearance. There is very little irrigated agriculture in the urban centre of Kumasi. Although production may be physically distant from the urban centre the presence of the large urban market is essential in explaining the strength of the sector. Almost 75% of farmers market their produce in Kumasi and 40% of the traders buying from the field sell into Kumasi.

- In the 63 villages surveyed an average of 44% of farmers are involved in irrigation. The level of activity varies greatly from site to site, dependant primarily on the availability of water but 20% of the villages report that 60% or more of farmers are involved in DSVP.

- 84% of respondents report that irrigated vegetables provide the largest source of cash income to the household. The proportion of produce consumed by the household is insignificant as a fraction of the total farm production although the beneficial contribution of fresh vegetables to the household diet should not be overlooked. However, dry season irrigation is not for the household's food security but for income generation.

- Data to determine full crop budgets were not collected in the survey but gross incomes per hectare for different crop types were determined based on estimates of yield and unit values. The values varied widely between crop types but the average, for a single crop, lies at about US$ 1,200 /ha. More detailed studies to determine the variable costs associated with different crops will be carried out in the second stage of study.

- Overall management of DSVP within the household normally rests with the husband. On average only 17% of DSVP farmers are women farming independently. However, women provide about 36% of the total labour input for all tasks, with particularly high inputs for irrigation (46%) and harvesting (60%).

- Informal irrigation is not new in the region. In 40% of the villages surveyed irrigation has been practised for more than 30 years. However, there is evidence of increasing numbers of farmers moving into irrigation over the last 10 years. Almost 60% of the villages reported that the number of farmers engaged in DSVP has increased significantly only in the period since 1990.

5.2 Irrigation Characteristics

- The condition of the irrigated plot varies greatly from sites with very uniform and well-maintained beds to sites that are only partially cleared and have no land forming. The size of the irrigated holding also varies. The overall mean is 0.9 ha but a small number of farmers (approximately 5%) report plots of 3 ha or more.

- A range of irrigation practices exists with regard to water source, method of water conveyance and application, the size and layout of the irrigated plot and the level of investment in equipment.

- Perennial rivers are the most widely used source but the use of shallow dug outs and water from stream pools are almost equally widespread. The water source often changes as the season progresses, initially relying on streams or stream pools and later using dug outs.

- There is no evidence of the use of gravity, i.e. ground slope, and earth channels to convey water from the source to the field. Nor is there any use of small dams or "improved wells" to store surface run-off, improve groundwater recharge or improve the yield of existing dug outs. For the majority of farmers (73%) water must be carried from source to field. 24% of farmers make regular or occasional use of a motorised pump.

- Half the respondents make use of an oil drum at the field edge to store water carried from the source. Water is then transferred from the drum to the crop. Only 25% carry water from the source and apply it directly to the crop.

- Half of the farmers interviewed use some paid labour to carry out irrigation and half rely solely on unpaid labour for this task. Where farmers pay for irrigation there is considerable variation in cost. In particular, payment per barrel appears to carry a very high cost compared with monthly or daily payment for irrigation but this requires further investigation. Where payment is per barrel farmers are paying as much as $US 5 per cubic metre. Given the very high costs of manual carrying it is likely that water is applied very sparingly to the crop, but this also requires further quantification in the second stage.

- The total numbers of men and women providing labour for watering are approximately equal but a much higher percentage of the women are paid for their labour. This reflects the fact that women are often paid to carry water over a considerable distance from source to field side where the water is temporarily stored in a 200 litre oil drum The farmer himself will then fill a bucket, tin or watering can from the oil drum and apply water to the crop.

- The distance that water is conveyed from source to field seems independent of the type of source. Roughly half the farmers using any source move water 50m or less from source to field, but for each source a minority of farmers (8 – 10%) are carrying (or pumping) water over 200m. The physical effort required to repeatedly carry water, often uphill, over this distance is hard to imagine but it does in part explain the high cost associated with irrigation water. Low cost water lifting technologies such as the treadle pump may offer significant benefits to these farmers.

- Equipment hire of high value items such as motorised pumps and sprayer and knapsack sprayers is relatively widespread, confirming that DSVP is a remunerative activity, well established in the cash economy of the region. It is not unreasonable to expect that if a new technology such as manual treadle pumps for water lifting was introduced then there could be significant opportunities for those buying the pumps to recoup their investment through hiring.

- Water costs and water quality:
  The price for water paid by pump owners, and those paying labourers on a daily basis are roughly equal at about $US 125 over a 4 month season. Those hiring pumps pay approximately 2 ½ times

more. Those paying for water per barrel may pay $US 480 over a season, almost 4 times that paid by those hiring day labour or by pump owners. Although the seasonal cost of owning and operating a pump is comparable with that of paying labour to carry water manually the volume of water provided by the pump will far exceed that lifted manually and where the owner chooses the pump can be hired out to generate additional income.

Concern over water quality is raised as much over water from dug outs as over water from the perennial streams. Although 25% of respondents believed the water to be unsafe to drink the largest part of this group draws water from dug outs. Thus, the concern of this research team and others over the high levels of organic pollution in the Subin and Oda rivers draining Kumasi and the perception that dugouts offer a cleaner water supply is not borne out in the views of the farmers.

5.3 Classification of Irrigation Methods

Based on some of these data a simple form of classification of irrigation methods is suggested in Table 12. This classification is proposed simply to assist in the selection of farms for more detailed study in the second phase of the project.

Table 12 A Classification of Irrigation Types

Conveyance	Conveyance Distance	Application	
Manual bucket	Short <50m	Oil drum	1
Manual bucket	Long >200m	Oil drum	2
Manual bucket	Short <50m	Direct to plants	3
Manual bucket	Long >200m	Direct to plants	4
Manual bucket	Short <50m	Oil drum	5
Manual bucket	Long >200m	Oil drum	6
Manual bucket	Short <50m	Direct to plants	7
Manual bucket	Long >200m	Direct to plants	8
Motorised pump (owned)	Short <50m	Sprayed from hose	9
Motorised pump (owned)	Long >200m	Sprayed from hose	10
Motorised pump (hired)	Short <50m	Sprayed from hose	11
Motorised pump (hired)	Long >200m	Sprayed from hose	12

5.4 Constraints Faced

Farmer ranking of constraints is illustrated in Figure 18. The shortage or unavailability of credit is the outstanding constraint identified by all farmers, irrespective of their irrigation method. Similarly, concerns over the unavailability of labour or land are of least concern to all farm types. Access to land, in particular, is ranked very low as a constraint to production.

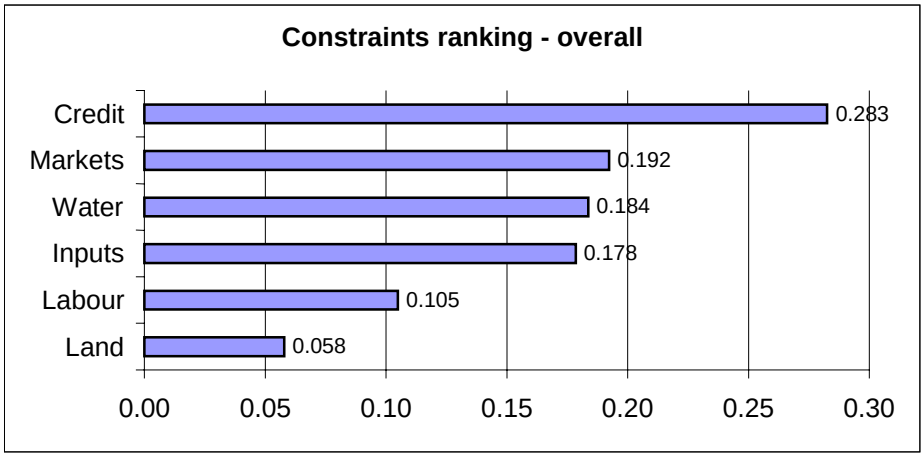
If no distinction is made between irrigation methods then access to markets, water and production inputs are seen as almost equally constraining. Amongst farmers with access to motorised pumps the second constrain after credit is produce marketing. This is understandable if these farmers cultivate a larger area than those relying on carried water and have higher levels of production which require marketing. The use of a pump implies that water is less of a constraining factor.

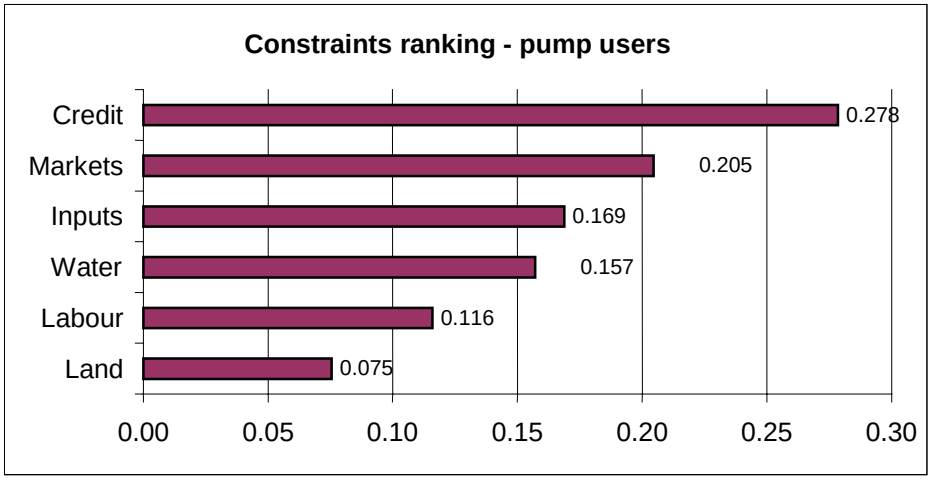
For the much larger group of farmers reliant on manually carried water, access to water ranks as the second greatest constraint after credit. 80 to 85% of the farmers questioned believe they are constrained by their water supply – they cannot apply as much as they would like, their yield is affected by water shortage or

water supply limits the area they cultivate. Amongst farmers reporting water as a constraint 72% identified the effort or cost involved in obtaining water as being the limiting factor. Only 28% referred to scarcity of water at the source. Thus, although in an important number of locations water is scarce, the much more common problem is that of moving sufficient water from the source to the crop.

5.5 Geographic Trends in the Data

There are no clear distribution patterns linking any of the observed parameters with radial distance from Kumasi nor are there any significant clusters in the results.





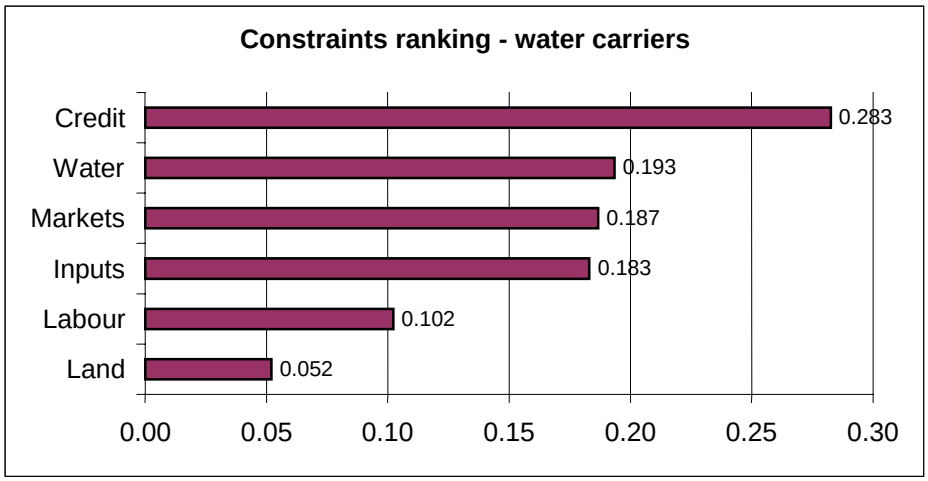


Figure 18 Farmers' Ranking of Constraints to DSVP

6. REQUIREMENTS FOR FURTHER DETAILED FIELD STUDIES

The questionnaire survey reported here has provided new information on the status and practice of informal DSVP in the peri-urban zone of Kumasi. The practice is already widely established where land and water resources are available, and has grown significantly in area and in terms of numbers involved over the last 10 years. For those who are able to move into DSVP it provides a very important, and apparently secure, source of cash income.

Although there is a significant minority of farmers (24%) who have regular or occasional access to motorised pumps or the pressurised mains supply of Kumasi (3%) for the majority, irrigation is an arduous and back-breaking task of manual water carrying with associated high water costs. Apart from the availability of water, farmers identify access to credit and the difficulties of produce marketing as key factors limiting their development of DSVP.

In order to gain a better understanding of the opportunities and constraints experienced by the peri-urban irrigators identified in this survey, a number of more focused studies are required to answer specific questions:

1. Although large numbers of farmers in many villages have taken up DSVP it is not clear whether they represent the more or less wealthy members of the community, whether they are drawn from a broad or narrow spectrum and whether DSVP has contributed significantly to their present wealth status. To answer these questions formal wealth ranking studies will be carried out in selected, representative villages.

2. Although farmers cite access to credit as the primary constraint to DSVP, 37% of respondents currently use some form of credit. Further study is required to understand the forms of credit presently available to informal irrigators, how they operate and what makes them unattractive. The study will also identify what forms of credit or micro-credit are available in other sectors and what barriers exist to their being made available to smallholder irrigators.

3. Problems of produce marketing – perishability and storage, transport, gluts, price fluctuations, and the actions of middlemen - are not unique to peri-urban irrigated production. However, some actions, such as co-operative action to plan planting and marketing, crop diversification and the use of reliable information on market prices can be used to overcome some of these problems. The broad questionnaire survey did not identify the extent to which any of these mechanisms are, or could, be applied to improve marketing. A study of existing marketing strategies and potential ways of improving upon them will therefore be carried out in a number of representative villages.

4. The questionnaire survey gathered a large amount of information on crop types and areas, labour use, irrigation methods and estimates of total crop value. However, all of this information is based on farmer recall with no opportunity to validate estimates or account for variations in the price or quantity of inputs or outputs used or generated over the season. In particular, the survey was only able to gain a first indication of the adequacy of irrigation water supply under different irrigation methods. Second stage studies will therefore monitor the daily production activities of approximately 20 farmers representing the range of farm types listed in Table 13. Data will be collected by means of a daily diary kept by the farmer and regularly monitored by a field researcher. This information will be used to determine farm budgets and the profitability of different crops as well as quantifying water costs and the adequacy of irrigation under different irrigation methods.

7. ACKNOWLEDGEMENTS

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Matilda Quainoo,	

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Appendices

Appendix 1

Field Notes Made During Initial Village Scoping Study

Appendix 1 Field Notes Made During Initial Village Scoping Study

	No in Sector	Sector	Village	Characteristics	No of Farmers
1		CENTRAL	14. Hall Six, UST	Cabbage, lettuce, onions, carrots, curry flowers, green pepper, green beans; buyers come from Kumasi market; shallow dug-outs in swampy areas	20
2		CENTRAL	15. Electricity Corp. & City Hotel area	Okro, tomatoes, egg plant, "ayoyo"; bucket water drawn from shallow dug-outs	
3	1	ENE	95. Akyease	Vegetable farmers here have migrated elsewhere (Hwereso) to farmer in dry season; 2 persons trying their hands here on cabbage	2
4	2	ENE	80. Ejisu Asamang	Shallow dug outs using buckets; cabbage, tomatoes, egg plant, okro, cucumber, water melon and carrots	4
5	3	ENE	77. Jakyi	Streams, shallow dug outs and buckets; tomatoes, egg plant, cabbage, carrots, lettuce	10
6	4	ENE	79. Baworo	stream and shallow dug-outs; tomatoes, egg plant, green pepper, onion, cabbage, carrots, lettuce water melon, cucumber	10
7	5	ENE	93. Duase	Stream and shallow dug outs using buckets through out; tomatoes, water melon, carrots, lettuce, green pepper, cabbage, cucumber, egg plant, okro	10
8	6	ENE	94. Kenyase	stream and shallow dug outs, hire labour to carry water by buckets; tomatoes, okro, egg plant, cabbage, cucumber, carrots, water melon, lettuce, sweet pepper	15
9	7	ENE	78. Tikrom	Streams and shallow dug outs, buckets and head carrying; tomatoes, egg plant, cabbage, carrots, cucumber, chilli pepper, okro	25
10	8	ENE	96. Juaben	Working along streams and in swampy areas based on shallow dug outs and the use the buckets; have been involved since 1979. Tomatoes, okro, cabbage, green pepper, cucumber, egg plant, carrots, and lettuce, selling produce in Kumasi	400
11	9	ENE	82. Atia	Shallow dug outs; egg plant, tomatoes, okro, chilli pepper	100+
12	10	ENE	99.Wonoo	No pump, streams believed to be reliable; majority hire labour to carry water by buckets; egg plant, green pepper, tomatoes, cabbage, carrots, water melon; egg plant sold at Effiduase, Kumasi market women come to buy tomatoes; carrots and cabbage sent to Kumasi by farmers; majority hire land	20+
13	11	ENE	98. Abotanso	No pump; spring water and swampy areas, carry water by buckets; tomatoes, onions, egg plant, okro, cabbage, lettuce; market women from Kumasi, Accra, Takoradi, Togo; have an association	300+
14	12	ENE	97. Kumawu	Streams and shallow dug outs using the buckets; tomatoes, okro, cabbage, egg plant, green pepper, carrots, lettuce; market women come from Kumasi, Accra, Takoradi, Togo	50+
15	1	ESE	73. Adwenase	Shallow dug-outs in river beds; tomatoes pepper, cabbage	2

	No in Sector	Sector	Village	Characteristics	No of Farmers
16	2	ESE	87. New Koforidua	Streams and shallow dug outs; cabbage, tomatoes, egg plant, okro;; sell produce in Kumasi and Konongo	8
17	3	ESE	84. Kubease	Hwire River, 2 farmers have pumps, some hire pumps majority use buckets; pay people to carry water; tomatoes, chilli pepper, egg plang, okro	10
18	4	ESE	74. Pease	No pump, buckets; tomatoes, egg plant, chilli pepper, cabbage, okra; sell produce in Asafo market-Kumasi	20
19	5	ESE	85. Duapompo	Shallow dug outs; tomatoes, egg plant, cabbage, okro; produce sold in Kumasi	20
20	6	ESE	89. Bomfa	5 pump owners, majority hire pumps, very few carry water in buckets; water supply from Banko River is reliable; tomatoes, egg plant, okro, chilli pepper, cabbage, carrots and lettuce; few women are involved but they are hired to carry water	20
21	7	ESE	90. Adumasa	4 pump owners, combination of carrying water by buckets and hiring pumps, but more people would carry water than would hire; shallow dug outs in river beds; egg plant, okro, tomatoes, carrots, cabbages, water melon, green pepper; note the tenure system, planting cocoa in return for food and vegetable crops	20
22	8	ESE	75. Kwaso	Work along the Baarko river, shallow dug outs when the river dries up; buckets; egg plant, tomatoes, cabbage sweet pepper, okro, water melon	25
23	9	ESE	81. Adadeentem	Streams and shallow dug outs, some reliable; egg plant, tomatoes, chilli pepper, onions, sell produce in Kumasi markets	30
24	10	ESE	88. Nobowam	6 farmers have pumps all other farmers hiring; nobody carries water anymore; chilli pepper, egg plant, tomatoes cabbage, carrots, green pepper and okro; sell produce in Kumasi and Accra by rail	35
25	11	ESE	76. Donyina	All shallow dug outs; tomatoes, egg plant	50
26	12	ESE	86. Boamadumase	5 persons have pumps, some hire pumps but the majority carry water using buckets; c30,000 per month for hired labour to carry water; tomatoes, egg plant, okro, pepper, "ayoyo"	100
27	13	ESE	83. Hwereso	Streams and shallow dug outs in river beds; tomatoes, egg plant, okro, pepper, cabbage; produce sent to Kumasi markets	100+
28	14	ESE	92. Konongo Odumase	Rely on rivers which are reliable, all hiring pumps from miners; sometimes hire people to carry water by buckets; tomatoes, egg plant, okro, chilli pepper, cabbage, water melon, carrots	100+
29	15	ESE	91. Pemenase	Work along rivers Buowin and Anunu; farmers are hiring pumps from other villages; majority carry water by buckets; tomatoes, egg plant, cabbage, okro, chilli pepper	50+
30	16	ESE	3. Twinduase-Kotei	(Yet to start); shallow dug-outs in swampy areas	
31	17	ESE	4. Kodiekrom-Deduako	Cabbage, lettuce, cucumber, green pepper; shallow dug-outs in swampy areas	

	No in Sector	Sector	Village	Characteristics	No of Farmers
32	18	ESE	5. Appeadu	Tomatoes, egg plant; some farmers were carrying water from the Oda River with buckets	
33	1	NNE	41. Agona	Tomatoes, okro, egg plant, cabbage; shallow dug outs	15
34	2	NNE	38. Asunua	Streams and shallow dug-outs; tomatoes, okro, egg plant, cabbage, green pepper, carrots; use chicken manure	20
35	3	NNE	42. Domeabra	Streams and shallow dug outs; tomatoes, egg plant, cabbage, pepper, onion	20
36	4	NNE	45. Bedomase	Streams and shallow dug-outs; tomatoes, pepper, egg plant, okro, cabbage, carrots; only indigenes	20
37	5	NNE	48. Amenase	Streams and shallow dug-outs; tomatoes, okro sweet pepper, cabbage, carrots; started about 8-10 years ago	20
38	6	NNE	43. Abrakasoa	Mainly from streams; tomatoes, carrots, cabbage	30
39	7	NNE	47. Boanin	Streams and shallow dug outs; tomatoes, chilli pepper, cowpea; started about 14-15 years ago and the number is increasing	30
40	8	NNE	49. Dormi	Started about 7 years ago; depend on streams and shallow dug-outs; tomatoes, chilli pepper, cabbage, sweet pepper, egg plant okro; farmers sell in Manpong and Kumasi markets themselves	60
41	9	NNE	40. Tano Odumasi	Stream water; chilli pepper, egg plant, tomatoes, okro; soil declining causing out-migration from the town	100
42	10	NNE	44. Gyamaase/ Kyikyiwire	2 pumps, streams and dug outs; tomatoes, egg plant, okro sweet pepper, cabbage	100
43	11	NNE	50. Kofiese	Rivers and shallow dug-outs using buckets tomatoes, egg plant, onion, pepper, cowpea; no one uses pump	130
44	12	NNE	46. Dawu	Streams and shallow dug-outs; egg plant, okro, tomatoes; started about 15 years ago	10+
45	13	NNE	51. Kwamang	Started in 1980, number increasing; irrigate from rivers, no pump; tomatoes, egg plant, sweet pepper, okro carrots	100+
46	14	NNE	39. Kona	Streams and shallow dug-outs; tomatoes, egg plant, pepper, okro, cabbage, lettuce, carrots; some hire land others own; have been involved for more than 15 yrs.	20+
47	15	NNE	59. Eduman	10 persons have pumps and hired by some farmers; cabbage, cucumber, carrots, lettuce, tomatoes, egg plant, chilli pepper, lettuce, curry flower	60+
48	1	NNW	53. Apagya	Along streams using buckets; tomatoes, chilli pepper, egg plant, cabbage	5
49	2	NNW	55. Pataase	Shallow dug-outs, some hire land, others own land; tomatoes, egg plant, chilli pepper, and okro	10
50	3	NNW	56. Pintsin	Stream water not reliable, shallow dug-outs also not reliable; irrigated farming over 15 years; tomatoes, okro, egg plant, chilli pepper	10
51	4	NNW	57. Esaase	Shallow dug-outs along rivers, some not reliable; tomatoes, egg plant, okro, chilli pepper; been in operation over the past 15 years	10
52	5	NNW	52. Kordie	Along streams using buckets; tomatoes, egg plant, okro, cabbage, chilli pepper	15
53	6	NNW	54. Akroforum	Streams, shallow dug-outs; some land hried; tomatoes, egg plant, chilli pepper and okro	20
54	7	NNW	67. Adukrom	Shallow dug outs sometimes not reliable; tomatoes, egg plant, chilli pepper, green beans	30

	No in Sector	Sector	Village	Characteristics	No of Farmers
55	8	NNW	58. Aduamoa	River and shallow dug-outs; dry season vegetable farming over 10 years; tomatoes, cabbage, okro, onions, egg plant, chilli pepper, lettuce, carrots	100
56	9	NNW	68. Sabrono	Stream and shallow dug outs, use buckets; tomatoes, egg plant, okro, chilli, green beans, green pepper, cabbage, carrots, water melon, cucumber, ; buyers from Kumasi, Accra, Takoradi, and Togo	200
57	10	NNW	1. Adankwame	Cabbage, tomatoes, use of piped water	
58	11	NNW	2. Fiano	Tomatoes, chilli pepper, okro, egg plant; draw water from river using buckets	
59	1	SSE	69. Eseresso	River Oda use buckets and shallow dug outs; tomatoes, okro, egg plant, cabbage, etc expects c6 million from 2 acres okro farm	2
60	2	SSE	70. Adagya	River Oda, all using pump; some use tractors to plough the land; tomatoes, okro, water melon, green pepper, egg plant; farmers are in groups of threes and fours	4
61	3	SSE	8. Amoamo	Tomatoes, chilli pepper	20
62	4	SSE	71. Dedesua	River Oda; 4 persons have pumps; some hire pumps, most of them use buckets; tomatoes, cabbage, egg plant, okro chilli pepper, green pepper	30
63	5	SSE	72. Aduaben	Oda River, 2 pumps some hire, majority use buckets; "ayoyo", tomatoes, egg plant, okro, chilli pepper	all
64	6	SSE	6. Adankrangya	Tomatoes, chilli pepper, okro, egg plant; bucket and pumps on the Adankran River; irrigated vegetable farming started in 1989; mostly indigenes	many
65	7	SSE	7. Amanase-Anwiam	Tomatoes, chilli pepper	many
66	8	SSE	9. Fawoman	Tomatoes, chilli pepper, egg plant; bucket and pump; witnessed pump demonstration on Akwasi Appiah's farm	many
67	1	SSW	36. Winiso No.2	1 person has pump, some hire pump but the majority of farmers depend on buckets; source of water being river and shallow hand dug-outs; egg plant, tomatoes, chilli pepper, okro, cabbage, carrots	30+
68	2	SSW	37. Winiso No. 3	Shallow dug-outs; okro egg plant, chilli pepper, tomatoes, cabbage, carrots	30+
69	3	SSW	13. Ofoase Kokoben-Anwia Nkwanta	Chilli pepper, tomatoes, okro; use of pumps from the Oda River	many
70	1	WNW	62. Dwenewoho	Same as Mfensi; one woman commutes daily to Mfensi	1
71	2	WNW	61. Asempanaye	Same as Mfensi; dry season vegetable growers all women travel daily to Mfensi	6
72	3	WNW	65. Adugyama	Shallow dug-outs, buckets and hire people to carry water- c1,500/drum; tomatoes, egg plant okro, chilli pepper, cabbage, cucumber	6
73	4	WNW	63. Mankranso	Rely on the Mankran River, reliable water supply; 1 person has twp pumps hired by some of the farmers whilst the others use buckets; cabbage, tomatoes, chilli pepper, egg plant, okro, onions which are usually sent to the Kumasi market by the farmers	50

	No in Sector	Sector	Village	Characteristics	No of Farmers
74	5	WNW	66. Fawoman	Streams and shallow dug-outs; egg plant, tomatoes, chilli pepper, okro cabbage, water melon; hired labour for all task at c30,000 per month	15+
75	6	WNW	60. Mfensi	Irrigated vegetable farming over the past 10 yrs; migrant dominate; work along the Offin River; 6 have pumps and the remaining farmers hire pumps	40+
76	7	WNW	64. Kunsu	Shallow dug-outs along streams; buckets only; crops include okro, egg plant, chilli pepper, cabbage, cucumber, water melon and tomatoes	40+
77	8	WNW	10. Atwima Akropong	Egg plant, okro; use of piped water by the St. Lawrence Catholic Church; 2 caretakers in charge of farm but not prepared to talk	
78	9	WNW	11. Koforidua	Cabbage, okro; use of piped water from nearby poultry farm; owners were not around	
79	10	WNW	12. Daaban	Lettuce, onions, carrots, cabbage; unmetered piped water, use of sprinkler; pay 30,000 cedis per month and in business for 2 years	
80	1	WSW	29. Koben	Tomatoes, cabbage; shallow dug-outs	1
81	2	WSW	30. Amankyaa	Cabbage; shallow dug-outs	1
82	3	WSW	23. Anyinamiso No 1	Chilli pepper, egg plant, tomatoes, okro, cabbage, lettuce; farmers depend on Anyinam River but no pump	2
83	4	WSW	17. Ahodwo	Egg plant, cabbage, pepper, French beans, okro; all farmers use buckets and shallow dug-outs	6
84	5	WSW	16. Sepaase	1 farmer uses pump, majority use buckets; tomatoes, egg plant, cucumber, okro, cabbage, chilli pepper	7
85	6	WSW	26. Anwia Futu	Okro, pepper, egg plant, tomatoes; 7 farmers have pumps; some hire but majority use buckets; most farmers hire land	20
86	7	WSW	27. Agogoso	Vegetable growing introduced about 3 years ago; no pump; okro, egg plant, tomatoes	20
87	8	WSW	34. Korku	Okro, egg plant, tomatoes, cabbage, chilli pepper; shallow hand dug-outs	20
88	9	WSW	18. Besease	3 have pumps, rest use buckets; over 90% of farmers work along Offin River; others work along the Onwabi River which is not reliable; tomatoes, egg plant, pepper okro, green beans, cabbage lettuce and carrots are produced for Kumasi market; majority hire land	25
89	10	WSW	30. Ahwirewa	Shallow dug-outs; egg plant, okro, tomatoes, chilli pepper; produce sent to Kumasi	25
90	11	WSW	22. Bedaabour	5 farmers have pumps, some hire pumps, but majority of farmers use buckets; cabbage, egg plant, okro, tomatoes, pepper, green pepper, cucumber, carrots; few own land; majority hire land; have vegetable growers association	30
91	12	WSW	32. Hiakwasi	Egg plant, tomatoes, chilli pepper; streams and shallow dug-outs	30
92	13	WSW	28. Amadaa	Pepper, tomatoes, okro, egg plant; 4 farmers have pumps, some hire but majority use buckets; hired land mainly by migrants	40
93	14	WSW	20. Nneribehi	Most farmers use buckets; 10 farmers have pumps, some hire pumps; majority depend on river, few use shallow dug-outs; okro, egg plant, tomatoes, pepper, cabbage, carrots, lettuce, are produced for Kumasi market; most farmers hire land	200

	No in Sector	Sector	Village	Characteristics	No of Farmers
94	15	WSW	19. Afari	No pump, shallow dug-outs in river beds and swampy areas; 2 farmers use piped water; tomatoes, okro, egg plant, cabbage, green pepper, chilli pepper, carrots, lettuce; 80% hire land; migrants and indignes (majority)	500
95	16	WSW	21. Mpasatia	Okro, pepper, egg plant, tomatoes, cabbage, onion, lettuce, carrots; 3 farmers use pumps, some hire pumps; town has a farming population of 200; and 1 out of 5 are not vegetable growers	150+
96	17	WSW	31. Asuonnu	Streams and dug-outs; tomatoes, egg plant, okro	20+
97	18	WSW	33. Abodiese	Okro, chilli pepper, tomatoes, egg plant, cabbage; shallow dug-outs; some hire land others own land	20+
98	19	WSW	35. Winiso No.1	Egg plant, chilli pepper, tomatoes, cabbage, okro; introduced over 20 years ago; use shallow dug-outs	30+
99	20	WSW	24. Kotokuom	6 out of every 10 farmers are dry season vegetable growers; pepper, okro, egg plant, cabbage, tomatoes (not important); 10 to 15 farmers have pumps; some hire pumps but majority use buckets; work along a river	many
100	21	WSW	25. Adeimbra	5 farmers have pumps; okro, egg plant, pepper; some hire pumps, most use buckets; 7 out of 10 farmers hire land	many
					4112*

* Count excludes all sites recorded as “many”

Appendix 2

Text of Questionnaires

Improved Irrigation in the Peri-Urban Zone of Kumasi
Scoping Study

Individual Farmer Information

HR Wallingford UK/ILMAD University of Science and Technology Ghana

Locality	
Name of Respondent	
Name of Enumerator	
Date of Interview	
Field Checker	

Module	Editing	Data Entry	Verification
1			
2			
3			
4			
5			
6			
7			
8			

Locality No.	Respondent ID

Section 1: General

1.1 Farmer Information:

1) Farmer's sex _____

2) How old is the farmer? _____3) Ethnicity _____

4) Region of origin? _____ 5) Marital status of farmer _____

6) How many people live in farmer's HH? _____

7) What is the education level of farmer? _____

1 Primary 2 Secondary/Vocational/Technical 3 Teacher training/ post secondary 4 University/Advanced diploma 5 Koranic 6 Never been to school

8) English comprehension _____

1 speak; 2 Read & write; 3 Both 1 & 2; 4 neither 1 nor 2

9) Main Occupation of farmer _____

1 farmer; 2 teacher; 3 trader; 4 driver; 5 mason; 6 carpenter; 7 cobbler; 8 mechanic; 9 seamstress/tailor; 10 cooks food; 11 chop bar; 12 hawker; 13 health worker; 14 construction labourer; 15 farm labourer; 16 police / force; 17 civil servant; 18 businessman/woman;
19 craftsman; 20 "Kayo-yoo"; 21 None; 22 Other (Specify)

10) Second Occupation of farmer _____ Use codes as in [9]

11) How long have you grown irrigated vegetables? (Years) _____

1.2 Do you farm the land in partnership with another person or persons?

1 Yes

2 No

1.3 If [1.2] is "Yes" what is the contribution from the partners and how is profit shared?

Contributes:	Self (%)	Partner 1 (%)	Partner 2 (%)
1. Land			
2. Labour			
3. Inputs			
Share of Profit:			

Locality No. Respondent ID

Section 2: Human, Social and Economic Factors

2.1 Which of these best describes the main objective of the farmer in growing irrigated produce?
Note: more than one answer may be circled.

1 Provide the main cash income for the household

2 Provide extra cash income for some household members

3 Provide income for future investment in another (new) business

4 Other (specify) _____

2.2 Do the household members do any of the following? Please rank them in importance for their overall contribution to household income. Rank the most important activity 1 and continue till you have ranked all your activities. If there are more than 6 activities, please rank the six most important and tick the others.

		HH member
	1 Salaried or waged work	
	2 Occasional labour/paid on a daily basis	
	3 Small businesses such as hair dressing, bike repair or similar business	
	4 Growing rainfed crops	
	5 Livestock such as sheep, goats, cattle for meat	
	6 Poultry for meat or eggs	
	7 Irrigated vegetables	
	8 Providing local transport such as taxi, cart or lorry or bicycle	
	9 Hawker	
	10 Other (specify) _____	

Locality No.	Respondent ID

2.3 Indicate whether paid or unpaid labour is used for the following tasks:

Activity	No	**Labour Type** 1. Self 2. Spouse 3. Other HH 4. Exchange 5. Paid 6. Unpaid 7. Other	**Men**		**Women**		**Children**		**Mechanised**	
			Paid	Unpaid	Paid	Unpaid	Paid	Unpaid	Paid	Unpaid
Land Preparation	1									
	1									
	1									
	1									
	1									
Planting/Transplanting	2									
	2									
	2									
	2									
	2									
Weeding	3									
	3									
	3									
	3									
	3									
Applying Chemical Fert	4									
	4									
	4									
	4									
	4									

Locality No. **Respondent ID**

Activity	No	**Labour Type** 1. Self 2. Spouse 3. Other HH 4. Exchange 5. Paid 6. Unpaid 7. Other	**Men**		**Women**		**Children**		**Mechanised**	
			Paid	Unpaid	Paid	Unpaid	Paid	Unpaid	Paid	Unpaid
Applying manure	5									
	5									
	5									
	5									
	5									
Applying agro-chemicals	6									
	6									
	6									
	6									
	6									
Watering	7									
	7									
	7									
	7									
	7									
Harvesting	8									
	8									
	8									
	8									
	8									

Locality No.	Respondent ID

2.4 Did you use credit when you first started irrigated vegetable cultivation?

1 Yes

2 No

2.5 If [2.4] is "Yes", where did you obtain credit?

1 Bank	5 Relative	9 Other (Specify)
2 Money lender	6 Household member	_____
3 Middleman	7 Co-operative or "Susu" group	
4 Friend	8 NGO	

2.6 Do you use credit now?

1 Yes

2 No

2.7 If [2.6] is "Yes", where do you obtain credit?

1 Bank	5 Relative	9 Other (Specify)
2 Money lender	6 Household member	_____
3 Middleman	7 Co-operative or "Susu" group	
4 Friend	8 NGO	

2.8 What problems are associated with obtaining credit?

_____

_____

_____

_____

_____

Locality No. Respondent ID

Section 3: Land Information

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

1 Yes 2 No

3.2 If [3.1] is "Yes", is the other land also irrigated for part or all of the year?

1 Yes 2 No

3.3 How much rainfed land in your HH is cropped in total?

Rainfed Location	Area (acres)

3.4 Provide the following information for each irrigated field under the control of the farmer:
If farmer has more than one irrigated plot at different locations consider only the most important. If a single plot is divided into several fields ***and more than one is irrigated,*** *give information for each field within the plot.*

1. Field identification			
2. Approximate size of field (acres)			
3. Distance of field from house (miles)			
4. How many years have you farmed the field?			
5. Does flooding occur 1 Never 2 In some years 3 Every year			
6. How many months a year is field flooded?			
7. Do you continue to farm the field on raised beds when it is flooded? (Yes / No / N/A)			
8. For how much of the year do you irrigate crops on this field? 1 All through the year 2 Indicate the months			
9. How long has the field been cultivated under irrigation? [If known] (years)			
10. Current tenure? 1 Owned 2 Share tenant 3 Cash tenant 4 Temporary holding 5 Other (specify)			
11. Amount paid in rent			
12. Term if cash rental (months)			
13. Term if share cropped 1 Abunu 2 Abusa			

Locality No.	Respondent ID

Section 4: Water Management

4.1 Water source

1 Mains supply (piped)

2 Stream/river (perennial)

3 Stream pool

4 Shallow dug out

5 Stream pools and later dug outs

6 Deep well or borehole

7 Natural pool/pond

8 Gutter

9 Other (specify) _____

4.2 Approximate distance from centre of field to water source:

Source:			
Distance (armspan)			

4.3 Conveyance from source to field

1 Manually (bucket / watering can)

2 Pumped

3 Manually but occasional pump hire

4 Stand-pipe and hoses

5 Other (specify) _____

4.4 Field application method. *More than one method may be circled*

1 From watering can/bucket/tin filled at the source

2 From watering can/bucket/tin filled from field-side oil drum

3 From hose pipe without sprinkler (fire service technique)

4 From hose and shower head held in the hand

5 From hose and mounted sprinkler

6 Other (specify) _____

4.5 Does your access to water limit the area that you cultivate in any part of the year because:

1 The source may dry up

2 Requires too much effort to carry more water

3 No

Locality No. Respondent ID

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 If [4.7] is "no", why?

_____

_____

4.9 Does water quality influence your choice of irrigated crops?

1 Yes

2 No

4.10 If the quality or quantity of water has been a significant problem what efforts have you made, individually or jointly with others, to improve the situation?

_____

_____

_____

4.11 How much do you pay for water?

[1] Item	**[2] Amount**	**[3] Term** 1. per barrel 4. per month 2. per irrigation 5. Other (specify) 3. per day
PUMP		
Hire charge		
Fuel		
Labour		
CARRIED		
Labour		
PIPED		
Water bill		
Labour		

Locality No.	Respondent ID

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

1 Yes

2 No

4.13 If [4.12] is "No", what is it that limits the amount you apply:

1 Cost of labour to carry or apply water
2 Cost of water tariff
3 Cost of pump hire or operation
4 The work is too hard
5 Not enough water available at the source
6 Water quality and fear of crop damage
7 Other (specify) _____

Section 5: Equipment and Infrastructure

5.1

[1] Type of Equipment & Infrastructure 1 machete 6 watering can 11 spraying machine 16 plastic pipe 2 hoe 7 water hose 12 napsack 17 well construction 3 mattock 8 sprinklers 13 basket 18 barrel 4 pickaxe 9 drippers 14 bucket 19 other (specify) 5 shovel 10 pumping machine 15 basin								
[2] Quantity bought or constructed								
[3] Where is it stored? 1. Farm 2. House								

5.2 Is any equipment hired or shared?

1 Hired 2 Shared 3 No

5.3 If equipment is hired or shared, which equipment?

Equipment	Shared or hired S / H	Hire cost	Hire Term

5.4 Does the farmer borrow any equipment?

1 Yes

2 No

5.5 If [5.5] is “Yes” what equipment does he/she borrow? _____

Locality No.	Respondent ID

Section 6: Cropping Information

6.1 Record the annual cropping pattern

Field identification _____

Crop	S	O	N	D	J	F	M	A	M	J	J	A	Area (acres)	Yield	Unit	Price per unit
Example: Garden eggs		Irrigation frequency 5 days											½	100	Sack	11,000

Locality No. Respondent ID

Field identification _____

Crop	S	0	N	D	J	F	M	A	M	J	J	A	Area (acres)	Yield	Unit	Price per unit
Example: Garden eggs		Irrigation frequency 5 days											½	100	Sack	11,000

6.2 Do you use, for any of your crops: (Enter “Y” or “N” in each cell.)

Crop:								
Commercial seed								
Herbicides								
Insecticides								
Fungicides								
Chemical Fertiliser								
Manure								

6.3 Have you received any formal training in vegetable production?

1 Yes

2 No

6.4 If [6.3] is "Yes", describe training

When? _____

Where? _____

6.5 If [6.3] is “No”, how did you learn about irrigated vegetable cultivation?

_____

_____

_____

6.6 Are some of your crops stolen from the field?

1 Yes

2 No

6.7 If [6.6] is "Yes", is this

1 A major problem

2 A minor problem

Section 7: Marketing

7.1 How do you sell the produce?

1 Take produce to a market (where)

_____

2 Individual consumers buy from the field (where do they come from)

_____

3 Traders buy from the field (where do they come from) _____

4 Other (specify) _____

7.2 Do you market your produce as:

1 An individual?

2 A member of an informal group?

3 A member of a co-operative?

Section 8: Farmers Conception of Constraints

8.1 Are you planning to expand your irrigation activity?

1 This year

2 Next year

3 Sometime

4 Never

8.2 Which factor most inhibits your irrigated production at present?

	Water	Land	Labour	Inputs	Credit	Marketing	Total Score
Water							
Land							
Labour							
Inputs							
Credit							
Marketing							

8.3 Do you experience any harassment because you are growing crops in this location?

1 Yes

2 No

8.4 If [8.3] is “Yes” from whom?

_____

Improved Irrigation in the Peri-Urban Zone of Kumasi

Community level information

Locality _____

Name of enumerator _____

Date of interview _____

Names of Key Informants _____

_____

_____

_____

1. What percentage of the working population are farmers? _____

2. Approximately how many farmers in the village irrigate crops in the dry season? _____

3. What percentage of the farmers does this represent? _____

4. Approximately how long have you been irrigating vegetables in this village? _____

5. Since when has the number of dry season vegetable growers been increasing in the village?

_____

6. What percentage of the dry season vegetable growers are:

Indigenes _____	Long term migrants _____	Daily Migrants _____
Male _____	Male _____	Male _____
Female _____	Female _____	Female _____

7. What are the main sources of water used for irrigation?

	Proportion
1 Mains supply (piped)	_____
2 Stream/river (perennial)	_____
3 Stream pool	_____
4 Shallow dug out	_____
5 Stream pools and later dug outs	_____
6 Deep well or borehole	_____
7 Natural pool/pond	_____
8 Gutter	_____
9 Other (specify) _____	_____

8. What crops are irrigated?

Crop	Popularity ranking

9. How many of the irrigating farmers:

Have pumps _____

Hire pumps _____

Carry water _____

10. What percentage of the irrigated vegetable growers:

Rent land the land irrigated _____

Own the land irrigated _____

11. Is there competition between needs for irrigation and domestic consumption?

1 Yes

2 No

Appendix 3

Summary Tables of Results

VILLAGE LEVEL DATA

1.Percent of working population that are farming

Descriptives		
Mean	91.9%	
Minimum	75%	
Maximum	100%	
Standard deviation	7.6	
Frequencies	**Number**	**Percent**
< 70%	0	0.0
70 – 80%	12	19.1
80 – 90%	22	34.9
90 – 100%	29	46.0
TOTAL	**63**	**100.0**

2. Number of farmers in a village irrigating in the dry season

Descriptives		
Mean	127	
Minimum	10	
Maximum	2000	
Standard deviation	266	
Frequencies	**Number**	**Percent**
< 50	35	54.7
50 – 100	14	21.9
100 – 200	6	9.4
200 – 300	5	7.8
> 300	4	6.2
TOTAL	**64**	**100.0**

Total number of farmers engaged in irrigation = 8000

3. Percent of village farmers engaged in irrigation

Descriptives		
Mean	44.3%	
Minimum	1%	
Maximum	100%	
Standard deviation	25%	
Frequencies	**Number**	**Percent**
0 – 20%	11	17.5
20 – 40%	26	41.3
40 – 60%	13	20.6
60 – 80%	8	12.7
80 – 100%	5	7.9
TOTAL	**63**	**100.0**

4. Time that irrigation has been practised in the village (years)

Descriptives		
Mean	30.2	
Minimum	4	
Maximum	55	
Frequencies	**Number**	**Percent**
< 5 yrs	1	1.6
5 –10	3	4.8
10 – 15	9	14.3
15 – 20	15	23.8
20 – 25	3	4.8
25 – 30	6	9.5
> 30 yrs	26	41.3
TOTAL	**63**	**100**

5. Since when have numbers irrigating been increasing?

Frequencies	**Number**	**Percent**
before 1980	3	5.0
1980 – 85	10	16.6
1985 – 90	12	20.0
1990 – 95	28	46.7
Later than 1995	7	11.7
TOTAL	**60**	**100**

6. Percentage of the growers who are Indigenes or migrants, male and female

Descriptives	**% Indigenes**		**% Migrants**			
Mean	81.3%		17.7%			
Minimum	30.0%		0.0%			
Maximum	100.0%		70.0%			
Standard Deviation	17.9%		17.9%			
	% male	**% female**	**% male**	**% female**	**Overall % male**	**Overall % female**
Mean	79.5%	20.6%	72.0%	2.2%	83.1%	16.9%
Minimum	20.0%	0.0%	0.0%	0.0%	44.0%	0.0%
Maximum	100.0%	80.0%	100.0%	37.5%	100.0%	56.0%
Standard Deviation	16.0%	16.0%	43.5%	7.7%	12.9%	12.9%

Distribution of Indigenes in villages

Frequencies	**Number**	**Percent**
<= 30%	1	1.6%
30 – 40%	4	6.5%
40 – 50%	1	1.6%
50 – 60%	3	4.8%
60 – 70%	7	11.3%
70 – 80%	13	21.0%
80 – 90%	16	25.8%
90 – 100%	17	27.4%
TOTAL	**62**	**100.0**

7. Water sources ranked by extent of use

Water source	Score
River	2911
Dug out	2222
Stream pool then dug out	2155
Stream pool	710
Mains supply	60
Well / bore	40
Pond	11
Other	1
Gutter	0

Number of villages relying on or more source type

Single source	14
Two sources	37
Three sources	10
Four sources	2

8. Crops ranked by popularity (most widely cultivated)

Crop	**Score**
Tomato	386
Egg plant	340
Hot Pepper	297
Okra	273
Cabbage	171
Carrots	35
Green Pepper	34
Cucumber	28
Onion	27
Water melon	26
Fr Beans	22
Ayoyo	16
Lettuce	8

9 a. Percent of irrigators in a village owning a motorised pump

Frequencies	**Number**	**Percent**
0.0%	33	52.4%
0 – 5%	17	27.0%
5 –10%	9	14.3%
10 – 15%	3	4.8%
> 15%	1	1.6%
TOTAL	**63**	**100**

9 b. Percent of irrigators in a village hiring a motorised pump

Frequencies	Number	Percent
0%	40	63.5%
0 – 15%	5	7.9%
15 – 30%	5	7.9%
30 – 60%	5	7.9%
60 – 90%	5	7.9%
> 90%	3	4.8%
TOTAL	**63**	**100**

9 c. Percent of irrigators in a village carrying water

Frequencies	Number	Percent
0%	8	12.7%
0 - 25%	7	11.1%
25 –50%	4	6.3%
50 – 75%	9	14.3%
75 – 100%	35	55.6%
TOTAL	**63**	**100**

10 Percent of irrigators renting land in a village

Frequencies	Number	Percent
0 - 25%	1	1.6%
25 –50%	7	11.1%
50 – 75%	18	28.6%
75 – 100%	37	58.7%
TOTAL	**63**	**100**

11. Competition between needs for irrigation and domestic consumption

17% of locations report some degree of competition

PERI-URBAN IRRIGATION STUDY
HR WALLINGFORD UK / ILMAD, UST, GHANA

QUESTIONNAIRE SURVEY - KUMASI
12. SUMMARY OF COMMUNITY LEVEL RESULTS

Village	Water Source										% pumping & manual carrying				Number & gender			Tenure		Crops																	
	Mains supply	River	stream pool	dug out	Pool then dug out	well/bore	Pond	Gutter	Other	Competition between irrigation & domestic need	% Pump owners	% Pump hirers	% Carry	% Hire carrying labour	Number of irrigators	Male	Female	% renting land	% Owning land	Tomato	Hot Pepper	Egg plant	Cabbage	Okra	Carrots	Lettuce	Cucumber	Water melon	Green Pepper	French Beans	Spring onion	Onion	Ayoyo	Sude	Other	Number of crops
Total	2	38	11	37	34	1	2	0	1						8,038					63	63	61	55	61	35	20	26	29	28	12	4	14	5	1	1	
Average											5	44	78	55	128	83%	17%	77	22																	7.6
Anweafutu		✓			✓					✓	10	7	83		60	67%	33%	70	30	✓	✓	✓		✓											4
Assuowunu				✓	✓						3		97		30	67%	33%	50	50	✓	✓	✓	✓	✓							✓				6
Afari				✓	✓						0		100		300	80%	20%	90	10	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓					10
Mousahah		✓		✓						✓	1	7	92		300	44%	56%	80	20	✓	✓	✓	✓	✓	✓	✓					✓				✓	9
Besease		✓			✓						5		95		60	93%	8%	100	0	✓	✓	✓	✓	✓					✓						6
Korku		✓		✓		✓							100		15	80%	20%	70	30	✓	✓		✓	✓												4
Nwiniso				✓	✓								100		60	78%	22%	80	20	✓	✓	✓	✓	✓			✓									6
Winisosekyikurom		✓	✓		✓						1	29	70		80	86%	14%	50	50	✓	✓	✓	✓	✓	✓			✓								7
Asarekrom		✓			✓							22	63	15	41	90%	10%	78	25	✓	✓	✓	✓	✓	✓		✓	✓								8
Nsiana		✓			✓								64	36	25	76%	24%	100	0	✓	✓	✓	✓	✓	✓			✓								7
Apemanim				✓						✓			100		30	77%	23%	40	60	✓	✓	✓	✓	✓			✓	✓				✓				8
Pekyi				✓	✓								100		70	79%	22%	50	50	✓	✓	✓	✓	✓			✓				✓	✓				8
Domenase				✓	✓						1		100		80	74%	26%	70	30	✓	✓	✓	✓	✓			✓									6
Manso Akropon		✓	✓										20	80	30	91%	9%	80	20	✓	✓	✓	✓	✓												5
Afransie		✓									5	100			100	n/a	n/a	70	30	✓	✓	✓		✓												4
Ofoase Kokoben		✓								✓	10	90			500	96%	5%	100	0	✓	✓	✓	✓	✓												5
Adankranya		✓	✓								10		100		70	61%	39%	90	10	✓	✓	✓	✓	✓												5
Anwiam		✓		✓	✓					✓			100		30	100%	0%	60	40	✓	✓	✓	✓	✓												5
Amoamo		✓		✓	✓						5	40	55		20	75%	25%	70	30	✓	✓	✓		✓												4
Faaman		✓	✓								9	100			100	85%	15%	99	1	✓	✓	✓		✓												4
Feyiase		✓	✓							✓	5	40	60		65	85%	15%	80	20	✓	✓	✓	✓	✓												5
Adagya			✓	✓							15	65	20		20	95%	5%	95	5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓				12
Dedesua		✓		✓							7	64	29		70	100%	0%	70	30	✓	✓	✓	✓	✓	✓			✓				✓	✓			9
Adwaden		✓									1	33	67		150	60%	40%	30	70	✓	✓	✓	✓	✓	✓		✓	✓				✓				10
Donyina				✓							7		93		30	97%	3%	83	17	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓					10
Kwaso					✓								100		30	97%	3%	100	0	✓	✓	✓	✓	✓		✓		✓	✓							8
Pease				✓	✓								100		40	95%	5%	90	10	✓	✓	✓	✓	✓												5
Mfensi		✓			✓						9		92		70	93%	7%	100	0	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓						10
Tikurom				✓									100		40	75%	25%	100	0	✓	✓	✓		✓												4
Baworo				✓					✓				100		30	100%	0%	100	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						11
Etia				✓			✓						20	80	300	72%	29%	5	95	✓	✓	✓		✓					✓						5
Hwereso		✓			✓						4	10	76	10	50	90%	10%	80	20	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓					10
Boamadumase		✓	✓	✓							4	50	50	50	200	100%	0%	70	30	✓	✓	✓	✓	✓	✓		✓	✓	✓							9
Nobewam		✓									6	94			50	86%	14%	90	10	✓	✓	✓	✓	✓	✓	✓		✓	✓							9
Adumasa		✓									15	50	35		40	85%	15%	70	30	✓	✓	✓	✓	✓	✓		✓									7
Odumase (Konongo)		✓		✓	✓					✓		30	70		12	92%	8%	90	10	✓	✓	✓	✓	✓	✓		✓		✓	✓						9
Kumawu		✓			✓								100		300	93%	7%	80	20	✓	✓	✓	✓	✓				✓	✓							7
Juaben				✓	✓								100		200	95%	5%	70	30	✓	✓	✓	✓	✓	✓		✓	✓	✓							9
Asaman				✓						✓			95	5	10	68%	32%	90	10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						12
Abotanso		✓		✓									90	20	450	58%	43%	70	30	✓	✓	✓	✓	✓	✓	✓		✓								8
Kofiase		✓	✓								0		100		500	81%	19%	60	40	✓	✓	✓	✓	✓	✓	✓		✓		✓						10
Kwaamang				✓	✓								100		30	91%	13%	70	30	✓	✓	✓	✓	✓	✓											6
Tano Odumase				✓	✓					✓			100		300	93%	7%	70	30	✓	✓	✓	✓	✓	✓	✓										7
Abrakaso				✓	✓								100		30	67%	33%	70	30	✓	✓	✓	✓	✓			✓									6
Boanim					✓									100	40	95%	5%	90	10	✓	✓	✓	✓	✓	✓	✓					✓					8
Amenase		✓											100		50	100%	0%	70	30	✓	✓		✓				✓	✓			✓					6
Domeabra		✓		✓										100	60	98%	2%	80	20	✓	✓	✓	✓	✓							✓					6
Adumoa		✓		✓	✓								100		50	60%	40%	70	30	✓	✓	✓	✓	✓	✓		✓	✓				✓				9
Aduman				✓	✓						1	4	94		180	72%	28%	80	20	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓				10
Adankawame	✓	✓		✓	✓						3	25	72		40	88%	12%	90	10	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓				11
Bari		✓										80	20		50	94%	6%	90	10	✓	✓	✓	✓	✓	✓		✓	✓	✓							9
Akuroforom				✓									66	34	20	75%	25%	100	0	✓	✓	✓														3
Offinso	✓	✓	✓	✓						✓	6	21	16	75	50	76%	24%	40	10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓					11
Sabronum				✓	✓					✓	0		100		2000	95%	5%	80	20	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓				11
Adukkurom				✓	✓								100		60	75%	25%	70	30	✓	✓	✓		✓						✓						5
Fawoman				✓	✓								100		30	67%	33%	90	10	✓	✓	✓	✓	✓				✓				✓				7
Biemso 1		✓	✓		✓								100		50	92%	9%	30	70	✓	✓	✓	✓	✓	✓	✓	✓		✓							9
Kunsu		✓		✓	✓							5	10	90	150	92%	8%	80	20	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							11
Mankranso		✓	✓		✓						1	10	65	25	50	82%	18%	100	0	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓						10
Pasro		✓			✓						14	70	17		30	80%	20%	80	20	✓	✓	✓	✓	✓	✓	✓			✓			✓				9
Dabaa		✓			✓						4		86		50	82%	18%	90	10	✓	✓	✓	✓	✓	✓		✓	✓								8
Esaase		✓		✓										100	30	99%	1%	100	0	✓	✓	✓	✓	✓	✓				✓							7
Duase		✓		✓			✓						100		30	70%	30%	100	0	✓	✓	✓	✓	✓	✓	✓	✓	✓								9

INDIVIDUAL FARMER DATA

SECTION 1: GENERAL INFORMATION

1.1 Farmer's sex

Sex	Number	Percent
Male	351	85.6
Female	59	14.4
TOTAL	410	100.0

1.2 Farmer's age (years)

Descriptives		Female	Male
Mean	38.1	43.6	37.1
Minimum	18	21	18
Maximum	72	72	69

Frequencies	Number	Percent
Age<20	2	.5
20-24	18	4.4
25-29	58	14.1
30-34	76	18.5
35-39	92	22.4
40-44	71	17.3
45-49	43	10.5
50-54	23	5.6
55-59	14	3.4
Age>= 60	13	3.2
TOTAL	410	100.0

Age cross tablulated with sex

Age range		Male	Female	Total
15<age<=20	Count	2		2
	% within SEX	0.6%		0.5%
20<age<=25	Count	14	4	18
	% within SEX	4.0%	6.8%	4.4%
25<age<=30	Count	55	3	58
	% within SEX	15.7%	5.1%	14.1%
30<age<=35	Count	72	4	76
	% within SEX	20.5%	6.8%	18.5%
35<age<=40	Count	83	9	92
	% within SEX	23.6%	15.3%	22.4%
40<age<=45	Count	58	13	74
	% within SEX	16.5%	22.0%	17.3%
45<age<=50	Count	32	11	43
	% within SEX	9.1%	18.6%	10.5%
50<age<=55	Count	18	5	23
	% within SEX	5.1%	8.5%	5.6%
55<age<=60	Count	10	4	14
	% within SEX	2.8%	6.8%	3.4%
60<age	Count	7	6	13
	% within SEX	2.0%	10.2%	3.2%
Total	Count	351	59	410
	% within SEX	100.0%	100.0%	100.0%

1.3 Farmer's ethnicity

Ethnic group	**Number**	**Percent**
Asante	365	89
Fante	19	4.6
Grushi	23	5.6
Wassa	2	0.5
B/A	1	0.2
TOTAL	410	100.0

1.4 Region of origin

Region	**Number**	**Percent**
A/R	362	88.3
Eastern	2	.5
Other	4	1.0
Central	10	2.4
Upper East	10	2.4
Western	5	1.2
B.A /R	8	2.0
N/R	6	1.5
Upper West	1	.2
Volta	1	.2
Gt. Accra	1	.2
TOTAL	410	100.0

1.5 Marital status

Frequencies	**Number**	**Percent**
Single	32	7.8
Married	344	91.7
Divorced	18	4.4
Separated	2	0.5
Widowed	14	3.4
TOTAL	410	100.0

1.6 Number of people living in the household

Descriptives		
Mean	7.1	
Minimum	1	
Maximum	37	
Standard deviation	3.52	
Frequencies	Number	Percent
1-2	20	4.9
3-4	55	13.5
5-6	125	30.7
7-8	99	24.3
9-10	62	15.2
11-12	25	6.1
13-14	8	2.0
number>=15	13	3.2
TOTAL	407	100.0

1.7 Education level

Frequencies	Number	Percent
Primary	309	75.4
Secondary/Vocational/Tech	52	12.7
Technical/post secondary	4	1.0
University	3	0.7
Koranic	1	0.2
No schooling	41	10.0
TOTAL		100.0

Education level cross-tabulated with sex

	Number		Percent	
	Male	Female	Male	Female
Primary	266	43	75.8	72.9
Secondary/Voc./Tech.	52		14.8	
Technical/ Post Sec.	4		1.1	
University	3		0.8	
Koranic	1		0.3	
No schooling	25	16	7.1	27.1
TOTAL	351	59	100.0	100.0

1.8 Level of English comprehension

Frequencies	Number	Percent
Speak	37	9.1
Read/write	26	6.4
Speak/read/write	224	55.2
None	119	29.3
TOTAL	406	100.0

Level of English comprehension cross-tabulated with sex

	Number		Percent	
	Male	Female	Male	Female
Speak	33	4	9.4	9.0
Read/write	21	5	6.0	6.3
Speak/read/write	212	12	60.4	54.6
None	81	38	23.1	29.0
TOTAL	347	59	100.0	100.0

1.9 Main occupation of farmer

Frequencies	Number	Percent
Farmer	378	92.2
Teacher	3	0.7
Trader	3	0.7
Driver	5	1.2
Mason	1	0.2
Carpenter	3	0.7
Seamstress/Tailor	1	0.2
Civil servant	5	1.2
Health worker	2	0.5
Other	9	2.2
TOTAL	410	100.0

1.10 Second occupation of farmer

Frequencies	**Number**	**Percent**
Farmer	34	8.3
Teacher	3	0.7
Trader	52	12.7
Driver	3	0.7
Mason	10	2.4
Carpenter	3	0.7
Seamstress/Tailor	7	1.7
Cook	4	1.0
Chop bar	2	0.5
Hawker	2	0.5
Construction worker	3	0.7
Business	3	0.7
Craftsman	3	0.7
Cobbler	5	1.2
Mechanic	6	1.5
Other	37	9.0
None	233	56.8
TOTAL	410	100.0

1.11 Length of time practising irrigation (years)

Descriptives		
Mean	10.47	
Standard deviation	8.15	
Minimum	0.2	
Maximum	87	
Frequencies	Number	Percent
0 – 2 years	26	6.4
3 – 5	92	22.5
6 – 8	87	21.3
9 – 11	82	20.0
12 – 14	49	12.0
15 – 17	38	9.3
18 – 20	12	2.9
21 – 23	5	1.2
24 – 26	5	1.2
27 – 29	6	1.5
30 – 32	1	.2
33 – 35	6	1.5
TOTAL	409	100.0

1.12 Do you farm the land in partnership?

Frequencies	**Number**	**Percent**
Yes	45	11.0
No	363	89.0
TOTAL	408	100.0

1.13 Partnership arrangement

Frequencies	Number	Percent
Number with one partner	37	90.2
Number with two partners	4	9.8
TOTAL	41	100.0

SECTION 2: HUMAN, SOCIAL AND ECONOMIC FACTORS

2.1 Main objective of growing irrigated produce

Frequencies	Number	Percent
Main income	156	38.1
Main income + future invest.	49	12.0
Main income + other	23	5.6
Extra cash	28	6.8
Cash for future investment	9	2.2
Building	109	26.6
Travel abroad	6	1.5
Marry	2	0.5
Other	27	6.6
TOTAL	409	100.0

2.2 Household income sources, ranked by importance to overall income

Activity	% ranking the activity in this position					Rank score
	First	Second	Third	Fourth	Fifth	
Irrigated vegetables	84.4	12.9	2.2	0.2	0.0	23.8
Rain-fed crops	10.7	62.9	13.23	3.7	0.5	18.2
Small business	0.2	7.3	14.4	5.4	1.2	4.7
Other	3.9	7.3	10.2	2.0	0.2	4.4
Livestock	0.2	1.5	6.3	3.7	0.5	1.9
Hawker	0.2	2.4	5.9	2.2	0.2	1.8
Poultry	0.7	0.7	1.5	3.7	2.9	1.3
Salaried or waged work	1.0	1.7	2.9	1.2	0.0	1.2
Occasional labour	0.0	1.2	2.0	1.7	0.0	0.8
Providing local transport	0.0	0.0	0.2	0.0	0.0	0.04

Note: Maximum score = 25, minimum score = 0

2.2 Household members engaged in income generating activities

Activity	Irrigated Veg		Rainfed Crops		Small business		Livestock		Hawker		Poultry		Salaried/ waged		Occasional Labour		Transport	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Self	114	27.9	69	18.5	31	26.9	20	38.5	9	19.6	18	40.9	14	51.8	13	61.9	1	100
Spouse	0	0	3	0.8	58	50.4	0	0	26	56.5	0	0	10	37.0	2	9.5	0	0
Self and spouse	120	29.4	248	66.5	11	9.6	8	15.4	0	0	6	13.6	2	7.4	0	0	0	0
Self and Other	108	26.5	0	0	4	3.5	16	30.8	1	2.3	12	27.3	0	0	1	4.8	0	0
Self, spouse and other	64	15.7	49	13.1	2	1.7	6	11.5	2	4.3	6	13.6	0	0	0	0	0	0
Other	2	0.5	4	1.1	9	7.8	2	3.8	8	17.4	2	4.5	1	3.7	5	23.8	0	0
Total	408	100	373	100	115	100	52	100	46	100	44	100	27	100	21	100	1	100

2.3 Labour utilisation

2.3 (a) Percentage of respondents using different classes of paid and unpaid labour

	Land Preparation		Planting/ Transplanting		Weeding		Chemical Fert.		Mauring		Agro-Chemicals		Irrigating		Harvesting	
	P	U	P	U	P	U	P	U	P	U	P	U	P	U	P	U
Men	85.8	83.4	27.1	89.2	44.6	85.3	19.3	85.4	5.1	19.3	9.5	17.0	15.8	76.8	23.1	88.0
Women	5.1	16.3	25.8	65.1	33.4	60.5	15.6	57.0	2.2	6.1	2.9	15.4	33.6	64.6	45.6	83.6
Children	1.4	3.4	2.4	12.7	1.9	10.5	0.7	14.4	0	2.9	0.5	2.2	2.7	26.3	3.6	21.2

P = Paid
U = Unpaid

Estimates of total labour input by task and labour type

2.3 (b)

	Land Preparation		**Planting/ Transplanting**		**Weeding**		**Chemical Fert.**		**Mauring**		**Agro-Chemicals**		**Irrigating**		**Harvesting**		**Totals**	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Men	4183	93.9	1896	60.3	1938	58.0	933	51.5	273	69.8	184	57.7	1352	42.3	1481	34.0	12240	58.2
Women	223	5.0	1087	34.6	1250	37.4	723	39.9	84	21.5	114	35.7	1463	45.7	2595	59.7	7539	35.9
Children	49	1.1	159	5.1	155	4.6	156	8.8	34	8.7	21	6.6	384	12.0	273	6.3	1231	5.9
Total	4455	100	3142	100	3343	100	1812	100	391	100	319	100	3199	100	4349	100	21010	100
	21.2%		14.9%		15.9%		8.6%		1.9%		1.5%		15.2%		20.7%		100	

2.3 (c)

	Land prep	Planting	Weeding	Chem Fert.	Manure	Ag Chem.	Irrigation	Harvest
Use some paid labour	85.9%	41.2%	68.8%	29.8%	6.3%	25.9%	50.5%	53.9%
Use solely Unpaid labour	14.1%	58.8%	31.2%	70.2%	93.7%	74.1%	49.5%	46.1%
Self only	4.1%	5.6%	4.4%	13.7%	5.9%	39.3%	8.0%	1.7%

2.4 Use of Credit when starting irrigation

Frequencies	Number	Percent
Used credit	118	28.8
Did not use credit	292	71.2
TOTAL	410	100.0

2.5 Initial source of credit

Source of Credit	Number	Percent
N/A	294	71.7
Bank	11	2.7
Bank And Friend	1	.2
Money Lender	22	5.4
Middleman	18	4.4
Friend	17	4.1
Relative	31	7.6
Household Member	6	1.5
Co-Operative Or "Susu" Group	1	0.2
NGO	1	0.2
Other	8	2.0
TOTAL	410	100.0

2.6 Do you use credit now?

Frequencies	Number	Percent
Used credit	153	37.5
Did not use credit	255	62.5
TOTAL	408	100.0

2.7 Present source of credit

Source of Credit	Number	Percent
N/A	258	62.9
Bank	13	3.2
Bank & NGO	1	.2
Money Lender	27	6.6
Middleman	44	10.7
Friend	21	5.1
Friend & other	1	.2
Relative	25	6.1
Household Member	4	1.0
co-operative Or "Susu" Group	5	1.2
NGO	1	0.2
Other	10	2.4
TOTAL	410	100.0

Current use of credit cross-tabulated with sex

	Number		Percent	
	Male	Female	Male	Female
Does use credit	131	22	37.5	37.3
Does not use credit	218	37	62.5	62.7
TOTAL	349	59	100.0	100.0

2.8 Problems associated with obtaining credit

Problem	Number	Percent
N/A	3	0.7
Not Available	108	26.3
High Interest Rate	86	21.0
Other	80	19.5
Crop Failure	36	8.8
High interest rate & not Avail.	33	8.0
Delay In Facility	28	6.8
Cheating By Middle Men	19	4.6
High interest rate + Crop failure	11	2.7
Not available +crop failure	4	1.0
Crop failure + delay in facility	1	0.2
High interest rate +other	1	0.2
TOTAL	410	100.0

SECTION 3: LAND INFORMATION

3.1 Does the HH farm rainfed or irrigated land at more than location?

	Number	Percent
Land at another location	380	92.7
No other farmed land	30	7.3
TOTAL	410	100.0

3.2 Is the other land irrigated?

	Number	Percent
N/A	30	7.3
Also irrigated	55	13.4
Not irrigated	325	79.3
TOTAL	410	100.0

3.3 Total rainfed land holding (ha)

Descriptives		
Mean	2.43	
Standard deviation	4.13	
Minimum	0.1	
Maximum	41.68	
Frequencies	**Number**	**Percent**
0 - 0.5 ha	58	**14.1**
0.5 - 1	77	**18.8**
1 - 2	111	**27.1**
2 - 3	67	**16.3**
3 - 4	22	**5.4**
4 - 6	23	**5.6**
6 - 8	11	**2.7**
8 - 10	5	**1.2**
> 10 ha	12	**2.9**
TOTAL	**386**	**100.0**

3.4.1 Size of irrigated field (ha)

87 respondents (21%) reported two separate irrigated areas.

Descriptives	**Area 'a' (ha)**	**Area 'b' (ha)**	**Total holding (ha)**
Mean	0.769	0.817	0.944
Standard deviation	0.759	0.88	0.992
Minimum	0.053	0.012	
Maximum	9.106	5.666	

Based on total holding

Frequencies	**Number**	**Percent**
< 0.25 ha	56	13.7
0.25 - 0.49	100	24.4
0.5 - 0.74	63	15.4
0.75 - 0.99	58	14.2
1.0 - 1.99	89	21.8
2.0 - 2.99	24	5.9
3.0 - 3.99	9	2.2
4.0 - 4.99	7	1.7
>= 5.0 ha	3	0.7
TOTAL	409	100.0

3.4.2 Distance from house to field (km)

Descriptives		
Mean	2.135	
Standard deviation	2.279	
Minimum	0.00	
Maximum	19.31	
Frequencies	**Number**	**Percent**
<0.5 km	68	16.6
0.5 =< Distance < 1.0 km	98	23.9
1.0 =< Distance < 1.5 km	13	3.2
1.5 =< Distance < 2.0 km	68	16.6
2.0 =< Distance < 2.5 km	60	14.6
2.5 =< Distance < 3.0 km	2	0.5
3.0 =< Distance < 3.5 km	42	10.2
4.0 =< Distance < 4.5 km	17	4.1
4.5 =< Distance < 5.0 km	19	4.6
Distance >= 5.0 km	23	5.6
TOTAL	**386**	**100.0**

3.4.3 Number of years this farmer has cultivated this plot.

Descriptives		
Mean	5.78	
Standard deviation	5.895	
Minimum	0.00	
Maximum	40.0	
Frequencies	**Number**	**Percent**
0 – 1 yr	64	16.4
1.1 – 2	61	15.6
2.1 – 3	46	11.8
3.1 – 4	40	10.2
4.1 –5	40	10.2
5.1 – 6	41	10.5
6.1 – 10	49	12.5
10.1 – 15	23	5.9
15.1 – 20	16	4.1
> 20 yrs	11	2.8
TOTAL	**386**	**100.0**

3.4.4 Does flooding occur?

Descriptives	Number	Percent
Never	242	59.2
In some years	66	16.1
Every Year	101	24.7
Total	**409**	**100**

3.4.5 Number of months plot is flooded

Descriptives		
Mean	2.83	
Standard deviation	1.79	
Minimum	9	
Maximum	0	
Frequencies	**Number**	**Percent**
< 1 month	11	6.5
1 – 2	73	43.7
3 – 4	58	34.7
5 – 6	21	12.6
7 – 9	6	3.6
TOTAL	**169**	**100.0**

3.4.6 Do you continue to farm on raised beds when the field is flooded?

Descriptives	Number	Percent
Yes	41	24.7
No	125	75.3
Total	**166**	**100**

3.4.7 Part of the year irrigation takes place

Missing

3.4.8 How long has the field been under irrigated cropping? (years)

Descriptives		
Mean	6.90	
Standard deviation	7.56	
Minimum	0	
Maximum	68	
Frequencies	**Number**	**Percent**
0 – 1 yr	35	8.6
1.1 – 2	52	12.7
2.1 – 3	44	10.8
3.1 – 4	46	11.3
4.1 –5	39	9.6
5.1 – 6	36	8.8
6.1 – 10	70	17.1
10.1 – 15	29	7.1
15.1 – 20	15	3.7
>20 yrs	17	4.2
Don’t Know	25	6.1
TOTAL	**408**	**100.0**

3.4.9 Tenure

Tenure	**Number**	**Percent**
Owned	117	28.5
Share Tenant	13	3.2
Cash Tenant	216	52.7
Temporary Holding	35	8.5
Other	29	7.1
TOTAL	410	100.0

3.4.10 Monthly cash rental ($US/ ha)

Descriptives	**Plot a**		**Plot b**	
Mean	14.6		15.6	
Standard deviation	25.8		23.3	
Minimum	0.11		0.0	
Maximum	209		83.7	
Frequencies	**No.**	**%**	**No.**	**%**
0 – 5 $US	69	34.2	15	41.7
6 – 10	55	27.2	9	25.0
11 – 20	44	21.8	5	13.9
21 – 30	15	7.4	2	5.6
31 – 40	6	3.0	0	0.0
41 – 50	2	1.0	1	2.8
51 – 60	0	0.0	0	0.0
61 – 70	3	1.5	2	5.6
> 70 $US	8	4.0	2	5.6
TOTAL	**202**	**100**	**36**	**100**

3.4.11 Term if share cropped

Tenure	**Number**	**Percent**
Not applicable	401	97.8
Abunu	6	1.5
Abusa	3	0.7
TOTAL	410	100.0

Abunu = 50:50 share of proceeds with the landlord

Abusa = Two thirds of produce or proceeds to the producer and one third to the landlord.

SECTION 4: WATER MANAGEMENT

4.1 Water Source

Source	Number	Percent
Perennial stream/river	115	28.0
Shallow dug out	85	20.7
Stream pool then dug outs	84	20.5
Stream then dug outs	38	9.3
Stream pool	33	8.0
Stream then stream pool	18	4.4
Deep well or borehole	12	2.9
Piped mains supply	11	2.7
Other	9	2.2
Gutter	3	0.7
Natural pool / pond	2	0.5
TOTAL	410	100.0

4.2 Distance from field to source (metres)

	Mains		Stream/River		Stream pool		Shallow dug out		Stream pool + Dug out	
Mean	147.8		154.6		159.3		211.1		295.2	
Sd	258.4		415.3		435.4		633.8		1668.5	
Max	900.0		4,356.0		3,168		4,356.0		17,424	
Min	0.0		0.9		10.8		0.0		0.0	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
0 – 50 m	5	45.5	76	43.9	26	49.1	77	63.1	53	48.2
51 – 100	1	9.1	45	26.0	12	22.6	19	15.6	25	22.7
101 – 200	4	36.4	31	17.9	8	15.1	7	5.7	15	13.6
201 – 300	0	0	7	4.0	0	0.0	4	3.3	3	2.7
301 – 400	0	0	7	4.0	5	9.4	5	4.1	5	4.5
401 – 500	0	0	0	0.0	1	1.9	1	0.8	1	0.9
> 500 m	1	9.1	7	4.0	1	1.9	9	7.4	8	7.3
Total	11	100	173	100	53	100	122	100	110	100

	Deepwell		Pond		Gutter		Other	
Mean	238.6		95.4		15.6		336.4	
Sd	436.1		102.9		9.9		535.2	
Max	1,584		270.0		27.0		1584	
Min	10.8		27.0		9.0		18	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
0 – 50 m	6	40.0	3		3	100.0	4	50.0
51 – 100	2	13.3	0		0	0.0	0	0.0
101 – 200	4	26.7	1		0	0.0	1	12.5
201 – 300	0	0.0	1		0	0.0	1	12.5
301 – 400	1	6.7	0		0	0.0	0	0.0
401 – 500	0	0.0	0		0	0.0	0	0.0
> 500 m	2	13.3	0		0	0.0	2	25.0
Total	15	100	5	100	3	100	8	100

4.3 Conveyance from source to field

Conveyance	**Number**	**Percent**
Bucket / watering can	299	72.9
Motorised Pump	57	13.9
Manually with occasional pump hire	40	9.8
Stand pipe from mains	9	2.2
Other	5	1.2
TOTAL	410	100.0

4.4 Field application method

Application method	**Number**	**Percent**
Bucket/ watering can fill from oil drum	139	33.9
Bucket / watering can filled at source	106	25.8
Manually both from oil drum & direct from source	65	15.8
Open ended hose	56	13.7
From oil drum & pump + hose	22	5.4
Manual from source & Pump + hose	10	2.4
Hose and mounted sprinklers	4	1.0
Hose and “shower-head” held in hand	5	1.2
Other	3	0.7
TOTAL	410	100.0

4.5 Does access to water limit the area you cultivate?

	Number	**Percent**
Requires too much effort to carry more water	170	41.5
The source may dry up	70	17.1
Too much effort & the source may dry	111	27.1
No	59	14.4
TOTAL	410	100

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

	Number	**Percent**
Yes	335	81.7
No	75	18.3
TOTAL	410	100

4.7 Would you drink the water you use for irrigation?

	Number	**Percent**
Yes	307	75.2
No	101	24.8
TOTAL	408	100

4.8 Reasons given for not drinking

	Number	**Percent**
Pollution/dirty/sewage	70	65.4
Coloured/milky	16	15.0
Infected with worms & bacteria	11	10.3
Other	10	9.3
TOTAL	107	100

4.9 Does water quality influence choice of crop?

	Number	Percent
Yes	23	6.1
No	356	93.9
TOTAL	379	100

4.10 Efforts made to improve quality or quantity of water supply

	Number	Percent
No effort made	130	31.7
Deepen well or dig more shallow dug outs	125	30.5
Buy a pump	111	27.1
Other	44	10.7
TOTAL	410	100

4.11 Payment for water

Reported for three types of water acquisition:

Motorised pump owners Manual carrying

Motorised pump hirers

Motorised pump owners

	Expenditure ($US) per day on		
	Fuel	Labour	Total operation
mean	5.4	6.2	6.0
Sd	4.1	3.9	4.8
Maximum	16.9	8.5	16.9
Minimum	0.4	1.7	0.4
Number reporting	18	3	18

Motorised pump hirers

		Expenditure ($US) per day on		
	Pump hire	Fuel	Labour	Total operation
mean	10.1	4.6	5.1	15.2
Sd	6.1	4.9	3.6	9.0
Maximum	42.4	29.6	12.7	42.4
Minimum	1.1	1.4	0.8	2.1
Number reporting	68	68	15	68

Manual carrying

	Expenditure ($US)		
	per Barrel	per day	per month
mean	1.02	3.19	15.55
Sd	0.47	4.03	7.58
Maximum	2.54	21.18	42.35
Minimum	0.13	0.85	4.24
Number reporting	95	70	25

4.12 Are you able to apply as much water as you like?

	Number	Percent
Yes	73	17.9
No	335	82.1
TOTAL	408	100

4.13 What limits the amount applied?

Application method	Number	Percent
Cost of labour + too hard	102	25.9
Cost of pump hire or operation + too hard	92	23.4
Work is too hard +not enough water at source	69	17.6
Work is too hard	64	16.3
Not enough water at source	41	10.4
Cost of labour + not enough water at source	9	2.3
Other	8	2.0
Cost of pump hire or operation + not enough water at source	6	1.5
Cost of water tariff	2	0.5
TOTAL	393	100.0

SECTION 5: EQUIPMENT & INFRASTRUCTURE

5.1 Equipment types and place of storage

Equipment type	No. of farmers owning	No. of farmers reporting storage:		Av. number of units / farmer	Max no. held by an individual
		in the house	in the field		
Machete	427	355	71	2.8	10
Hoe	388	99	288	3.5	20
Basket	243	205	38	5.8	50
Bucket	230	165	62	2.8	6
Shovel	104	59	44	1.4	3
Watering can	92	27	65	1.9	4
Mattock	91	19	72	1.6	5
Basin	80	71	9	1.1	6
Knapsack sprayer	63	58	5	1.2	2
Pickaxe	59	30	29	1.4	4
Barrel	49	8	41	1.6	4
Motorised sprayer	42	41	1	1.2	2
Water hose	28	4	24	4.4	30
Pump	21	19	2	1.1	2
Well	7	1	6	3.6	7
Sprinkler	3	0	3	1.7	2
Plastic pipe	1	0	1	20.0	20

5.2 Is any equipment hired or shared?

	Number	Percent
Hires equipment	277	67.6
Shares equipment	13	3.2
Neither	120	29.7
TOTAL	410	100

5.3 Types of equipment that are hired or shared

Equipment	Number of farmers Sharing	Number of farmers hiring	Mean hire charge $US/day	Max hire charge $US/day	Standard deviation of hire charge
Motorised sprayer	2	97	2.0	8.5	1.3
Pump	2	74	8.1	19.1	4.6
Knapsack Sprayer	2	22	1.3	14.8	1.4
Barrel	4	22	1.1	12.7	2.7
pickaxe	1	12	0.9	1.7	0.6
Shovel	3	11	1.2	4.2	1.2
Mattock	3	10	0.8	1.7	0.6
Water hose	3	7	1.5	4.2	1.8
Hoe	1	5	1.4	3.4	1.7
Plastic pipe	2	4	1.0	2.1	0.9
Other	0	3	0.9	1.7	0.7
Watering can	1	2	0.6	0.8	0.3
Machete	1	1	1.4	1.4	
Sprinklers	0	1	8.5	8.5	
Well	1	1	5.9	5.9	

5.4 Borrowing of equipment

	Number	Percent
Number borrowing	274	67.7
Number not borrowing	131	32.3
TOTAL	405	100

5.5 Types of equipment borrowed

Equipment	Number of farmers borrowing
Barrel	53
Knapsack	43
Hoe	28
Mattock	23
Pickaxe	21
Shovel	21
Sprayer	16
Basket	16
Bucket	13
Basin	8
Watering can	8
Hose	5
Other	3
Sprinklers	3
Machete	2
pump	2
Plastic pipe	2
Total	267

SECTION 6: CROPPING INFORMATION

6.1 (a) Crop areas and Gross incomes Sorted by Total area

Crop	Total Area (ha)	Total Income ($US)	$/ha
Tomato	99.29	133,323.7	1,342.7
Garden Egg	84.06	135,017.8	1,606.2
Okra	77.70	94,680.9	1,218.5
Hot Pepper	55.61	69,049.1	1,241.7
Cabbage	18.45	83,954.0	4,551.3
Lettuce	16.44	2,704.6	164.5
Ayoyo	5.06	1,061.4	209.8
Cucumber	4.66	7,168.9	1,539.0
Watermelon	4.05	3,388.4	837.3
Green Pepper	3.51	2,606.7	742.9
Carrot	2.89	4,670.9	1,614.2
Onion	2.02	1,812.8	895.9
Green Bean	1.67	1,585.1	948.4
Spring Onion	1.13	173.7	153.3
Total	376.54	541,198	

6.1 (b) Crop areas and Gross incomes Sorted by Gross Income per hectare

Crop	Total Area	Total Income	$/ha
Cabbage	18.45	83,954.0	4,551.3
Carrot	2.89	4,670.9	1,614.2
Garden Egg	84.06	135,017.8	1,606.2
Cucumber	4.66	7,168.9	1,539.0
Tomato	99.29	133,323.7	1,342.7
Hot Pepper	55.61	69,049.1	1,241.7
Okra	77.70	94,680.9	1,218.5
Green Bean	1.67	1,585.1	948.4
Onion	2.02	1,812.8	895.9
Watermelon	4.05	3,388.4	837.3
Green Pepper	3.51	2,606.7	742.9
Ayoyo	5.06	1,061.4	209.8
Lettuce	16.44	2,704.6	164.5
Spring Onion	1.13	173.7	153.3
Total	376.54	541,198	

6.1 (c) Number of farmers reporting cultivating each crop and average area of plots

Crop	Total Area (ha)	No of Farmers	Average area (ha)	Max. area (ha)	Stdev
Tomato	99.29	193	0.51	3.24	0.44
Garden egg	84.06	177	0.47	4.86	0.56
Okra	77.70	153	0.51	7.28	0.84
Hot pepper	55.61	114	0.49	6.07	0.62
Cabbage	18.45	53	0.35	1.21	0.24
Cucumber	4.66	20	0.23	0.81	0.18
Green pepper	3.51	17	0.21	0.40	0.11
Lettuce	16.44	16	1.03	11.74	2.87
Carrot	2.89	12	0.24	0.61	0.20
Ayoyo	5.06	10	0.51	2.02	0.58
Green bean	1.67	9	0.19	0.40	0.11
Onions	2.02	7	0.29	1.21	0.41
Spring onion	1.13	6	0.19	0.40	0.14
Sulve	0.30	6	0.15	0.20	0.07
Water melon	4.05	6	0.81	2.83	1.14

6.1 (d) Number of farmers growing a mix of crops

Frequencies	Number	Percent
Single crop	173	42.2
2 Crops	120	29.3
3 Crops	80	19.5
4 or more crops	37	9.0
TOTAL	410	100.0

6.1 (e) Irrigation frequencies (days between irrigation) according to crop type and irrigation method

	Ayoyo	Cabbage	Carrot	Chilli	Cucumber	Garden egg	Green Bean
Manual Irrigation							
No. of records	10	46	14	73	18	144	10
Av. Irrigation frequency	2	2.5	1.8	3	1.6	3	1.9
Modal irrigation frequency	3	3	1	3	1	3	1
Pumped or mains irrigation							
No. of records	2	11	2	39	2	48	0
Av. Irrigation frequency	5	3.5	3	5.5	3.5	5.5	
Modal irrigation frequency	n/a	3	3	7	n/a	7	

	Green Pepper	Lettuce	Okra	Onion	Spring Onion	Tomato	Water Melon
Manual Irrigation							
No. of records	15	14	118	6	4	203	6
Av. Irrigation frequency	2.2	1.8	3.1	2.2	1	2.3	1.3
Modal irrigation frequency	3	1	3	1	1	3	1
Pumped or mains irrigation							
No. of records	3	2	44	1	0	14	2
Av. Irrigation frequency	3.3	1	5	7		4.9	6.5
Modal irrigation frequency	3	1	7	7		7	n/a

6.2 Use of inputs

	No.	Seed		Herbicide		Insecticide		Fungicide		Chem fert		Manure	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Ayoyo	9	7	77.8%	1	11.1%	6	66.7%	5	55.6%	6	66.7%	2	22.2%
Cabbage	53	52	98.1%	8	15.1%	53	100.0%	53	100.0%	46	86.8%	23	43.4%
Carrot	13	12	92.3%	3	23.1%	11	84.6%	11	84.6%	12	92.3%	3	23.1%
Cucumber	17	14	82.4%	3	17.6%	17	100.0%	16	94.1%	16	94.1%	5	29.4%
Garden egg	164	83	50.6%	38	23.2%	163	99.4%	161	98.2%	160	97.6%	27	16.5%
Green bean	9	8	88.9%	0	0.0%	9	100.0%	9	100.0%	9	100.0%	2	22.2%
Green Pepper	14	13	92.9%	1	7.1%	14	100.0%	14	100.0%	12	85.7%	5	35.7%
Hot pepper	94	31	33.0%	35	37.2%	92	97.9%	91	96.8%	88	93.6%	15	16.0%
Lettuce	14	14	100.0%	1	7.1%	14	100.0%	14	100.0%	3	21.4%	12	85.7%
Okra	142	80	56.3%	39	27.5%	142	100.0%	138	97.2%	133	93.7%	21	14.8%
Onion	6	6	100.0%	2	33.3%	6	100.0%	6	100.0%	3	50.0%	4	66.7%
Spring onion	4	2	50.0%	0	0.0%	4	100.0%	4	100.0%	1	25.0%	3	75.0%
Sulve	1	1	100.0%	0	0.0%	0	0.0%	0	0.0%	1	100.0%	0	0.0%
Tomato	222	98	44.1%	46	20.7%	222	100.0%	218	98.2%	215	96.8%	26	11.7%
Water melon	4	4	100.0%	0	0.0%	4	100.0%	4	100.0%	4	100.0%	0	0.0%
Mean use of input			77.8%		14.9%		89.9%		88.3%		80.2%		30.8%
Minimum use of input			33.0%		0.0%		0.0%		0.0%		21.4%		0.0%

6.2 Crops sorted by level of input use

Index	Crop
4.833	Onion
4.585	Cabbage
4.353	Cucumber
4.286	Green Pepper
4.231	Carrot
4.214	Lettuce
4.169	Okra
4.117	Hot pepper
4.111	Green bean
4.085	Garden egg
4.000	Water melon
3.923	tomato
3.500	Spring onion
3.111	Ayoyo
2.000	Sulve

6.3 Training in vegetable production

	Number	Percent
Some training	40	9.8
No training	368	90.2
TOTAL	408	100

6.6 Are crops stolen from the field?

	Number	Percent
Yes	145	35.9
No	259	64.1
TOTAL	404	100

6.7 Is theft a major or minor problem?

	Number	Percent
A major problem	59	40.1
A minor problem	88	59.9
TOTAL	147	100

SECTION 7: MARKETING

7.1 a) Different marketing methods

	Number of farmers reporting	% of Sample
Take produce to market	363	88.5
Consumer buys from field	141	34.4
Traders buy from field	227	55.4
Other	21	5.1

b) Location and method of selling produce

	Take to Market in:		Consumer comes to field from:		Trader comes to field from:		Other	
Locally	28	6.5%	128	77.6%	24	6.8%	6	21.4%
Kumasi	317	73.4%	7	4.2%	143	40.5%	7	25.0%
Accra	9	2.1%	3	1.8%	72	20.4%	4	14.3%
Takoradi	2	0.5%	3	1.8%	26	7.4%	1	3.6%
Agona	18	4.2%	1	0.6%	5	1.4%	0	0.0%
Obuasi	19	4.4%	2	1.2%	28	7.9%	1	3.6%
Abroad	1	0.2%	0	0.0%	6	1.7%	0	0.0%
Other	38	8.8%	21	12.7%	49	13.9%	9	32.1%
Total	432	100.0%	165	100.0%	353	100.0%	28	100.0%

Note: Farmers often report selling to more than one location and by more than one method

7.3 Farmer organisation for marketing

	Number	Percent
Market as an individual	362	88.9
Market in a informal group	42	10.3
Member of a co-operative	3	0.7
TOTAL	407	100

SECTION 8: FARMERS' CONCEPTIONS OF CONSTRAINTS

8.1 Any plans to expand

	Number	Percent
This year	232	57
Next year	92	22.6
Sometime	78	19.2
Never	5	1.2
TOTAL	407	100

8.2 Constraint ranking

Potential constraint	Total Score	No. of 5's	Nuls
Credit	1729	213	4
Markets	1177	60	38
Water	1124	56	32
Inputs	1092	6	9
Labour	642	1	68
Land	354	3	228

8.3 Do you experience harassment?

	Number	Percent
No	399	98
Yes	8	1.9
TOTAL	407	100

Appendix 4

Seasonal Cost of Water for Irrigation

Appendix 4 Seasonal Cost of Water for Irrigation

In order to compare between the cost of water paid for on a per barrel, per day and per month basis, and compare between costs of manual water carrying and motorised pumping, a number of assumptions can be made:

1. Let the season duration = 4 months (120 days, December to March)

2. Let the average irrigation frequency = 3 days (for manual water carrying)
= 6 days (for motorised pumping)

3. Let the irrigated plot size = 0.4 ha (1 acre)

Based on these assumptions the approximate expenditure on water over a 120 day season can be determined as follows:

a) Payment per month:

Average payment = $US 15.5 /month *(From questionnaire results)*

Season duration = 4 months *(From assumption 1)*

Therefore seasonal expenditure on irrigation labour ≅ $US 62

b) Payment per day:

Average payment = $US 3.2 /day *(From questionnaire results)*

Number of days irrigation in season = 120 / 3 = 40 *(From assumptions 1 and 2)*

Therefore seasonal expenditure on irrigation labour ≅ $US 130

c) Payment per barrel:

Average payment = $US 1.02 /barrel *(From questionnaire results)*

Number of days irrigation in season = 120 / 3 = 40 *(From assumptions 1 and 2)*

Average number of barrels used during a day's irrigation = 12
(From farmer workshop 2/12/99)

Therefore seasonal expenditure on irrigation labour ≅ $US 480

d) Owners of motorised pumps:

Average total operating cost (fuel + labour) = $US 6.0 / day *(From questionnaire results)*

Number of days irrigation in season = 120 / 6 = 20 *(From assumptions 1 and 2)*

Therefore seasonal expenditure on water ≅ $US 120

e) Hirers of motorised pumps:

Average total operating cost (hire, fuel + labour) = $US 15.2 / day *(From questionnaire results)*

Number of days irrigation in season = 120 / 6 ≅ 20 *(From assumptions 1 and 2)*

Therefore seasonal expenditure on water ≅ $US 300

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