# The Peri-Urban Interface:

# a Tale of Two Cities

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# Contents

# 3 Characteristics of major cropping systems

## Cropping systems in the Hubli-Dharwad peri-urban interface

### *Sources of information.*

In a baseline study conducted in 1997, 25 villages around the twin cities of Hubli-Dharwad were characterised by the research team, including major production systems. A few months later, four of these villages were re-visited by the team, where surveys of a more participatory nature were carried out. The "Baseline Study for Hubli-Dharwad City-Region" Project (R6825) concluded with a workshop (University of Birmingham *et al.*, 1998a, 1998b). During the course of the subsequent project, "Improved Utilisation of Urban Waste in the Hubli-Dharwad City-Region" (R7099), field work was conducted in four villages, three of which had not been visited during the baseline study. In the course of the field work, intensive observations were made on farming practices of five farmers in each village (University of Birmingham *et al*., 1998c; 1999a; Nunan, 2000).

### *Systems*

The locations and principal distinguishing characteristics of the 25 villages are presented in University of Birmingham *et al*. (1998a, p.24-25). A picture emerges of great heterogeneity, both of farming systems and local employment. One major reason for heterogeneity is soil types (ibid, p.38). To the north east of the twin cities the soils are black cotton (vertic), and to the south west they are red (alfisols). The dominant food cropping systems on vertic soils are *kharif* Season (the wet south-west monsoon, June to October) cotton (*Gossypium herbaceum*), onion (*Allium cepa*), potato (*Solanum tuberosum*), green gram (*Phaseolus aureus*) groundnut (*Arachis hypogaea*), followed by *rabi* season (drier north-east monsoon, November to February) sorghum (*Sorghum bicolor*), wheat (*Triticum aestivum*), safflower (*Carthamus tinctorius*) and chickpea (*Cicer arietinum*), mostly maturing on residual moisture stored in the soil. On the alfisols, the dominant *kharif* cropping system is rice based (*Oryza sativa*) (usually drilled, rainfed paddy) with increasing areas of mango (*Mangifera indica*) orchards, and some cotton and maize (*Zea mays*). In the *rabi* season, rain and residual soil moisture permitting &rainfall data and trends over time are presented (University



of Birmingham *et al*., 1998a, Figures 4.1-4.8), green gram is commonly grown. Rainfall also varies across the peri-urban area. It falls into the Northern Transitional Zone of Karnataka State, with mean annual rainfall just exceeding 1000 mm to the west of Dharwad, and < 700 mm to the east. Furthermore, these generalisations of cropping systems hide great local variation. Thus, some villages specialise in floriculture (roses, gylardia, chrysanthemum), vegetables (often sewage irrigated), potato, mango and sapota (*Manilkara achras*). This heterogeneity is in stark contrast to peri-urban Kumasi, where there is less spatial variation in cropping systems.

In the "Improved Utilisation of Urban Waste Project" (R7099), the main cropping activities of the participating farmers, land area cultivated, cattle per farm and soil amendments are given (Nunan, 2000, p. 11). It was apparent that farmers have extensive knowledge about soil fertility maintenance, and prefer to use organic amendments wherever possible. Fallowing does not feature, and cropping intensity on farmed land is well over 100% (exact data not available, but two crops per year are the norm in the peri-urban zone).

One system which has been reasonable well characterised is the sewage irrigated system (Hunshal and Sindhe, 1997; Hunshal *et al*., 1997). Apart from the sewage irrigated system, knowledge on production systems is still rather general.

### *What is known about changes to production systems around Hubli-Dharwad driven by urban development*

The estimated current (2000) population of Hubli-Dharwad is 800,000, and the mean population density of the urban area in 1991 (time of the last census) was 3395 persons $km^{-2}$, when the population was 648,000. By Indian standards this is quite low (Indian 1991 mean urban population density was 5953 $km^{-2}$), part of the reason being that between the two cities, but within the municipal boundary, there are still areas of farmland. The mean population density of the surrounding rural areas in 1991 was 181 $km^{-2}$, which is moderately high for a rural area (for comparison, see population densities for other peri-urban zones in Chapter 2. In the 1991 census, 50.5% of the city-region’s population was classed as urban.

Evidence for Dharwad District points to increasing intensification of land use, for it shows that areas cropped have generally increased particularly during the 1980s (University of Birmingham *et al.,* 1998a, p.43). However, there is little sign that urban growth is a significant cause (ibid, p.44). Yet there has been a move towards cash yielding enterprises which is seen as taking advantage of proximity to Hubli-Dharwad (ibid, p.46). A particular case is that of the increase in mango farming, which uses local urban marketing institutions and copes with the increase in household non-farm employment (ibid, p.48). Floriculture is also rising and this is seen as due to the proximity of an urban market (ibid, p.50). There is increased growing of horticultural crops for urban markets and increased growing of crops which are processed in urban areas (e.g. mango and tomato) (ibid, p.64).

A feature of production systems around Hubli-Dharwad, particularly cash cropping systems, is that many primary producers are not dependent upon the twin cities for marketing (University of Birmingham *et al.*, 1998a, p.50-51). For example, chilli is marketed mainly at Sirsi, 100 km west of Hubli, potato is marketed in Belgaum, 75km north of Dharwad, and although the mango pulp factory near Hubli accounts for purchase of a lot of local production, much mango is still transported to Bombay for export, and to many parts of India for the fresh market. Flowers are marketed in Hubli, but also in Belgaum, where higher prices can be obtained. Cotton is marketed in Gadag, as well as Dharwad. Thus, the effect of the urban area upon cropping systems is rather less than might be expected from the size of the cities. However, the cities are important for marketing food crops, as resource flow diagrams show (Nunan, 2000, pp. 47 - 50). A table in University of Birmingham *et al*. (1998a, p. 51) shows that a considerable proportion of food crops are marketed, ranging from 20 - 22% for sorghum (local name: *jowah*) to 70 - 80% for wheat and rice in Hubli-Dharwad. Fresh vegetables (tomato, cabbage, cauliflower) are marketed in Hubli-Dharwad, much of the vegetables being sold through wholesale intermediaries (University of Birmingham *et al*.,1998a, p.52).

There has been no spatial analysis of urban effects upon agricultural production or soil fertility around Hubli-Dharwad. Studies of production have usually been at the taluk (sub-district) level, as that is how agricultural statistics are collected (e.g. University of Birmingham *et al*.,1998a, p.39-40). The resolution of these statistics is too coarse to be able to identify any peri-urban effects.

The only trends that have been described are temporal. For example, farmers in four villages were asked to describe changes in cropping systems from the 1950s to 1990s (University of Birmingham *et al*., 1998a, after p.44, graphs 4.6-4.9), and these showed considerable changes over time. However, a note of



caution must be sounded when this form of evidence is collected. The same farmers were also asked to describe trends in rainfall, and for Mugad they claimed that rainfall had halved since the 1970s, whereas rainfall data show that annual rainfall had increased over that period (ibid, Fig 4.5). Other temporal data have been collected at even coarser resolutions, at the district level (ibid, p.42-44). The conclusion is that there is a significant gap in knowledge about effects of urban growth upon production systems.

One effect of the urban area upon production systems has been via competition for unskilled labour between near-urban farms and urban employment (factories, construction work). An example of this and the effects upon farming practice was cited in University of Birmingham *et al*. (1998c, p.10). Farmers in Navalur village on the edge of Dharwad have found that the location of a textiles factory adjacent to the village has resulted in a significant shortage of labour at wages they can afford to pay (Rs 50 $d^{-1}$ compared to Rs 80 $d^{-1}$ paid by the factory). Farmers are responding by tilling the soil earlier in the season to expose it to the heat of the sun, so reducing insect pests and (it is claimed) increase levels of nitrogen. Those that use urban solid waste (USW) from the municipal dump now spread the waste onto fields prior to taking out pieces of glass and stones, to cut down on labour requirements. Waste pickers are then admitted to the fields to sort out and take away plastic, which they then sell for recycling. The farmers then plough in the USW. Previously, USW would have been sorted prior to spreading on the fields. Another response by farmers to higher wage levels has been to develop mango orchards. On the other hand, in more distant areas which are more agrarian and prosperous due to irrigation, wages are higher but there have been significant reductions in the proportion of population engaged in farming, indicating mechanisation University of Birmingham *et al*. (1998c, iv).

## *Characteristics of principal stakeholders in crop production*

Identification of stakeholders in the waste stream was conducted in University of Birmingham *et al*. (1999a, p.6-7). The characterization of farmers who have used urban solid waste is presented in some detail (ibid, p.30-32, 40-47), although these were a small sample. Characterization of small-scale farmers in the village of Mugad are presented (ibid, p.27-29, 33-39). These, too, were a limited sample, but give some indication of farmers and their livelihoods. Other peri-urban stakeholders were characterised to some extent in the Baseline Study (Hunshal and Nidagundi, 1997).

### *Livelihood strategies of the poor who are involved in crop production*

Farm maps and resource flow diagrams (originally drawn by the farmers) for two contrasting villages are presented (Nunan, 2000, pp. 47 - 50). The participating farmers were at the smaller end of the scale. The resource flow diagrams were descriptive only, and no data of the magnitude of flows were collected, so are deficient in that respect. Nonetheless, they indicate areas where future research workers should concentrate if they wish to characterise livelihoods.

### *What is known about potential strategy options for interventions in crop production*

The only intervention strategy which was investigated around Hubli-Dharwad was the effect of composted urban solid waste (USW) with various amendments upon kharif season crops grown by farmers in four peri-urban villages. These experiments were described in Nunan (2000), and results are presented in Table 3.1. For further details of the composts used see Chapter 5.

The first season's results indicated that in two villages, the addition of modified USW had no effect upon yields of crops, but significant effects were observed upon groundnut and potato, with USW plus night soil having the greatest effect. Moreover, ranking of the effects of composts upon crops also indicated that adding night soil to USW was the most beneficial treatment. However, one year is considered to be too short a period for accurately determining the effects of organic soil amendments, and longer term studies are desirable. The experiments were limited in scope, and thus yielded knowledge for only a small sector of peri-urban activities.

### *What is known about dissemination of knowledge to the peri-urban poor*

In Hubli-Dharwad, the means by which knowledge was disseminated to poor farmers during projects was via the participation process, and its effectiveness was not tested. The main extension agencies, the Karnataka State Departments of Agriculture, Horticulture and Livestock, operate the Training and Visit system, which as currently implemented appears to be confined to more

co-operative and 'progressive' farmers, and without a signal change in institutional attitudes and incentives for extension officers would be of little use in reaching the



poorest sector. The main agency involved in generating potential interventions, the University of Agricultural Sciences, co-operates closely with the State extension agencies, and interventions developed so far are mostly

suitable for high input systems. However, individuals working in the University are aware of the need to target farmers without the means to apply high inputs. If appropriate interventions are developed, the most promising means of transfer of knowledge would probably be using some of the more effective NGOs operating in the area.

**Table 3.1. Yields of crops in 1999 on-farm field trials, Hubli-Dharwad**

| **Village** | **Navalur (5)** | **Mugad (5)** | **Maradagi (4)** | **Halyal (3)** |
|---|---|---|---|---|
| **Crop** | **Potato** | **Rice** | **Greengram** | **Groundnut** |
| **Treatment** | **t/ha (fresh)** | **t/ha (paddy)** | **kg/ha (seed)** | **t/ha (in shell)** |
| **Sorted USW** | 23.0 bc | 4.04 | 485 | 1.41 a |
| **USW + DS** | 20.6 a | 3.60 | 407 | 1.38 a |
| **USW + V** | 20.9 a | 4.21 | 497 | 1.49 a |
| **USW + NS** | 23.5 c | 3.80 | 536 | 1.64 b |
| **FP** | 22.6 b | 4.30 | 427 | 1.45 a |
| **s.e.d.** | 0.333 | 1.01 | 60.0 | 0.067 |
| **P (treatment effect)** | <0.00 | 0.572 | 0.251 | 0.031 |
| **P (farmers)** | <0.00 | <0.00 | <0.00 | <0.00 |

Numbers in parenthesis after village names indicate numbers of farmers from whom valid results were obtained.

Navalur and Halyal data followed by similar letters indicate those means not significantly different (separated by Least Significant Difference).

USW = sorted and composted municipal solid waste
USW + DS = USW + distillery sludge
USW + V = vermicomposted USW
USW + NS = USW + night soil
FP = farmers' usual practice
s.e.d. = standard error of difference of means
P = level of probability in F test.

*Source:* Nunan (2000)

## Cropping systems in Kumasi peri-urban interface

### *Characteristics of major cropping systems*

During the inception phase of the Kumasi Natural Resource Management Project ( R6799), 65 (or 66 or 67, reports differed) villages were surveyed during the Village Characterisation Survey (VCS). These were located up to 35 km and in all directions from the city centre. This survey enumerated the villages in which certain crop species were present, but did not characterise the proportion of cultivable land assigned to each (Blake *et al*., 1997a, p. 54) nor specify the cropping system in which each species was grown. Scientific binomials were not used, so in some cases where only the English vernacular was given, it was not possible to determine the species. For example, 'yam' is presumably one or more members of the genus *Dioscorea,* but no further information was advanced. It is probably *D. alata*, the greater yam, or *D. rotundata*, the white guinea yam. 'Cocoyam' and 'water cocoyam' were listed, and refer to *Xanthosama sagitifolium*, and *Colocasia esculenta,* respectively (Adam *et al*., 1998, p.136-137). Taro was also referred to (Blake *et al*., 1997b), and from the husbandry details it is inferred that it is the same as water cocoyam (*C. esculenta*). Beans were also referred to, without any further qualification. This is an area of detail to which projects need to pay more attention.

The principal staples of the area, maize (*Zea mays*), plantain (*Musa* spp.) and cassava (*Manihot esculenta*) were present in all the VCS villages surveyed (with the exception of cassava being absent from one). 'Yam' and cocoyam (*X. sagitifolium*) were present in 58 and 56 villages, respectively, whilst water cocoyam (*C. esculenta*) was present in 50. Many villages also grew vegetables, particularly Solanaceous species: tomato (*Lycopersicon esculentum*), 'pepper' (presumably chilli, *Capsicum frutescens*), aubergine or 'garden egg' (*Solanum melongena*), and non-Solanaceous okro (*Hibiscus sabdariffa*) all being found in > 58 villages out of 65. The other predominant crop species was oil palm (*Elaeis guineensis*), present in 52 villages, and cocoa (*Theobroma cacao*), in 48.

More detailed participatory surveys were conducted in six villages, where farming systems were described. These villages were samples located at various distances from Kumasi (10 to 40 km from the city centre) and in various directions. Findings from these surveys were described in some detail (Blake *et al.*, 1997b, p.23-111), but presented in an anecdotal manner, with little analysis. Also, vernacular or non-specific English names were used for crops, and inputs



and outputs recorded in local measures without conversion. This reduced the usefulness of the report.

The striking difference in farming systems between Kumasi and Hubli-Dharwad is the homogeneity of the former compared to the apparent heterogeneity of the latter (University of Agricultural Sciences *et al*., 1997; University of Birmingham *et al*., 1998a). Besides the differences engendered by two contrasting soil types around Hubli-Dharwad (vertic and alfisol), various villages often specialized in particular cropping systems, such as rice, potato, wheat-sorghum, cotton-chilli, floriculture, mango, etc. This degree of specialisation seemed to be absent from around Kumasi. The farming systems around Hubli-Dharwad were dominated much more by livestock, particularly buffalo for milking and oxen for draught power and transport (see Chapter 4). The dung from the beasts was a significant factor in maintaining soil fertility in the peri-urban area, but this option was not available to farmers around Kumasi.

The principal cropping system around Kumasi was traditional maize – cassava – plantain – cocoyam mixed cropping, and was present in all six villages, predominantly practised by women (Blake *et al*., 1997a). Men tended to be engaged in cash cropping, the commonest forms being either tree crops (oil palm or cocoa) or vegetables (tomato, egg plant, cowpea, along with a much wider range of species but not found in every village). In wetter areas such as valley bottoms, crops that could take advantage of moist conditions were grown (colocasia taro, rice). Free-range small livestock (poultry, sheep) were present in all villages, and intensive poultry units were present in four villages. Cattle were present in only one village. Most villages had banned goats due to their destructive feeding habits.

The main differences between villages were determined by proximity to Kumasi. Respondents in all villages confirmed that fallow periods had shortened, and that soil fertility had declined as a consequence, but this effect was more marked nearer the city. In the two villages furthest from the city (at 30 and 40 km distance), rice (*Oryza* spp., presumed to be *O. glaberrima*) was grown as a food and cash crop. However, it needed long fallow periods (six years was cited), otherwise weed burdens increased. Cocoa plantations were being rehabilitated and new ones were being established in these two villages in response to much improved cocoa prices. There was some evidence of agricultural intensification, in that chemical herbicides were used on intensive sole maize and on rice, and intensive maize was sown in rows. Otherwise, cropping systems were similar to those found in villages closer to Kumasi, albeit with longer fallow periods due to lower pressure on land.

Another survey, not funded by NRSP, but conducted in eight peri-urban villages around Kumasi (Kasanga, 1998, p.98), showed that the great majority of female farmers (81%) grew food crops and on small farms of less than 0.8 ha, the equivalent figures for male farmers being 65% (see Table 6.12, Chapter 6). Unfortunately, the manner in which the data were presented did not permit a clear analysis of farming systems. It is possible to say that this survey confirmed other reports, that the major food crops were maize, cassava, plantain and xanthasoma taro, in that order, and that proportionally fewer male farmers grew food crops, and proportionally more grew vegetable crops than female farmers. 54% of male vegetable farmers were single, supporting other work showing that young males dominated this sector. Often these men had migrated from the north.

The great majority of farmers paid nothing for the land on which they farmed (81% of females and 74% of males), with a smaller proportion involved with share cropping (12% of females and 17% of males), but those who had access to land for no charge did not have security of tenure, either. 78% of female and 62% of male farmers still practiced bush fallowing (for further details on this subject, see Tables 6.13 and 6.14, Chapter 6). Farms run by male farmers were on average only slightly larger than for female farmers, but they tended to fallow for longer periods, indicating that crops occupied less of the farm at any one time. Data on livestock numbers from the same survey are presented in Chapter 4.

Thus, this survey corroborated the findings of the main research project (KNRMP), that food cropping with very short fallows dominated farming activities, with very few livestock in the system to help maintain soil fertility. This survey also supported those findings of the main research project that farmers overwhelmingly stated that tenure was not their main constraint, but that lack of credit / finance and poor soil fertility were.

In the Village Characterisation Survey (VCS), in 94% of the villages at least some farmers used chemical fertilizers, commonly 15:15:15 and ammonium sulphate, usually on vegetables. The proportion of villages where at least some farmers used insecticides, fungicides and herbicides were 88%, 66% and 58%, respectively. It was not stated which particular pesticides were used, nor upon what crops. At least some farmers used poultry manure in 26% of villages, but compost in only 3%. Poultry manure from intensive units was dumped and sometimes burned by roadsides, and its disposal was stated as being a problem for



poultry farmers. In the VCS villages (numbering 65 to 67), there were 97 commercial poultry units. Depending on the source of information, 57% (Kindness, 1999) or 80% (NRI, 2000a, p.12) of available poultry manure was used by farmers. There was an absence of good data on production from peri-urban home gardens, and how important they are in terms of food / cash generation.

Field work was conducted in 1994 by the Crop Utilisation Dept. at the Natural Resources Institute, Chatham, Kent (NRI), with staff of the University of Science and Technology (UST) (Fereday, 1997). The author of that report reviewed and consolidated knowledge generated by that project's field work. Surveys were conducted in a range of villages (reportedly 14, but profiles for only five are presented) located from 16 to 25 km from Kumasi, all on main roads (Table 3.2).

**Table 3.2 .Main horticultural and staple crops grown in Mim and Kodie villages in a survey conducted in 1994**

| **Horticultural species** | **Range of plot sizes (ha)** | **Staple crop species** | **Range of plot sizes (ha)** |
|---|---|---|---|
| Tomato | 0.2 – 4.0 | Cassava | 0.4 – 1.2 |
| Okra | 0.1 – 1.2 | Plantain | 0.1 – 0.6 |
| Aubergine | 0.1 – 0.8 | Maize | 0.2 – 2.0 |
| Cabbage | 0.4 – 0.8 | Xanthosoma taro | 0.3 – 1.2 |
| Chilli | 0.4 | Cowpea | 0.4 – 0.8 |

*Source:* Fereday (1997)

Fertilizer (usually various types of NPK) was applied to horticultural crops, but not to staple crops. These had to rely upon the residual effects of fertilizers applied to horticultural crops, if planted in the next cycle. There seemed to be little knowledge of organic manures with only a few farmers who kept poultry using the manure on horticultural crops. Reasons given for not using organic manures included: lack of knowledge, no access to manure, not as effective as chemical fertilizers and too bulky to transport.

Comments on soil fertility were that it had declined over time due to shortening of the fallow period (indicating an increase in cropping intensity) and the lack of, or decline in the use of fertilizer.

- When asked about pest and disease problems, various categories of pests were identified by farmers (e.g. beetle, caterpillar, cricket, nematode, blight). No scientific names were given in reports. There were few traditional methods for controlling pests and diseases apart from destroying infected plants. The commonest insecticide in use was 'Karate', a synthetic pyrethroid (lambda cyhalothrin), and 'Cymbush' (compound name not given). Farmers had little knowledge about identification of diseases, and tended to spray 'Dithane' (mancozeb), and if that failed to work, uprooted the plant to help slow the spread of the disease.

Main constraints identified were (Fereday, 1997):

- Non-availability of production credit, including finance for labour.
- Pests and diseases.
- No storage facilities for harvested produce.
- Lack of producers' associations or other leadership
- Costs of inputs.

The overall picture from the respondents (selection methods not presented) was of a farming system in rapid transition from low external input forest fallow agriculture for staples, to a higher input cash cropping system conducted largely by young males. Farming systems were still developing, and at the time of survey there seemed to be little indigenous knowledge about fertility maintenance and pest and disease control, all problems which followed in the wake of intensified production systems.

Surveys of farmers' perception of pest and disease problems in vegetable production were conducted in four villages within a 5 to 10 km radius of Kumasi (Critchley, 1998). This document provided a useful checklist of pests found by the author. Other reports apparently exist with details of diseases found, but these could not be located. The author's conclusion was that if farmers' perceptions of pest and disease problems that he observed are representative of the surveys which had been conducted in other villages, then farmers' knowledge of biotic factors reducing yield was greatly deficient. One consequence of this would be that any pesticides used could be inappropriately targeted and thus wasted, or at worst present a risk to the operator, consumer and the environment.

Overall, the characterisation of crop production systems is probably adequate for development of strategy options. However, the usefulness of the



characterisation of production systems was limited by the lack of quantitative data on areas devoted to each cropping system. The existence of images from two aerial digital photography missions and GIS allows one way of rectifying this important gap in knowledge.

### *What is known about changes to production systems around Kumasi driven by urban development*

Near the city, farming land is being sold by chiefs for housing development. Thus, less land is available for agriculture.

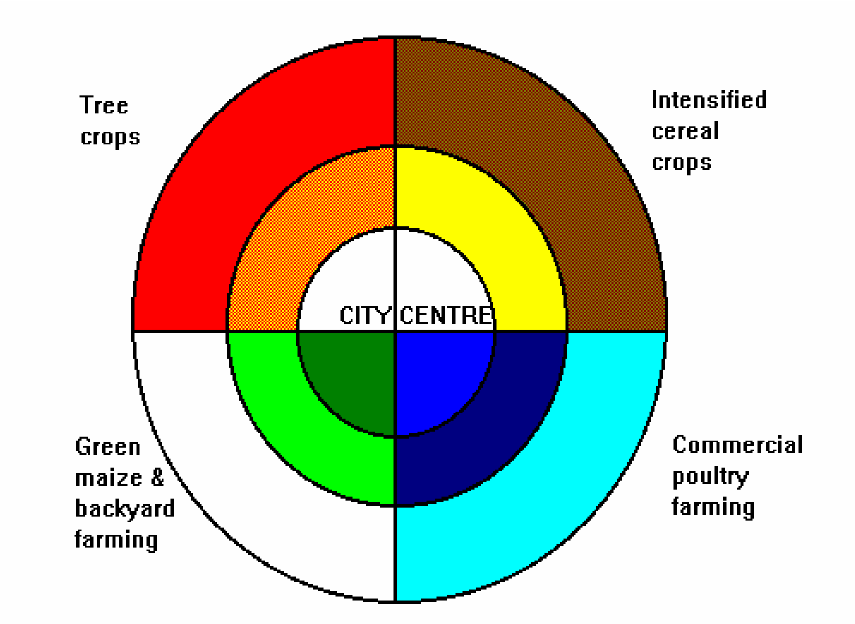
In the Village Characterisation Survey of KNRMP (Blake *et al*., 1997a, p.56) most villages reported changes in farming systems since 1983, the main ones being increased use of herbicide (53%), decreased soil fertility (32%), reduced fallow period (30%), and increases in maize and in vegetable farming (23% of villages reporting these). Fallow periods declined from an average of 6.2 years in 1983 to 2.8 years in 1997. In the six villages where PRA were conducted, reported changes were a move from intercropping to sole cropping of food crops, decreases in areas devoted to tree crops (particularly cocoa), and increases in vegetable production. Just which of the foregoing were changes driven by urban development was not ascertained, as farming systems would be expected to change in any case over time due to uptake of new technologies and increased population pressure. For example, a decrease in area of cocoa could be due to lower prices over the past decade, or to a perceived decrease in rainfall, which would not be a peri-urban effect. However, maps did indicate that tree crops were less frequent nearer the city (Blake *et al*., 1997a, Map 10) whereas the reverse was true of villages were tomatoes were grown (ibid, Map 11). The uptake of herbicide use appeared to be occurring mostly outside the peri-urban zone (ibid, p.81).

In a survey in 1994, trends in farming systems over time were ascertained from a range of farmers in five villages, mostly male (Fereday, 1997). The main features were:

- 1960s. More cocoa, plantain and xanthosoma taro. Much more forest and soils fertile, forest fallowing. High yields without fertilizer, bigger farms. Prices lower, so farming was not a profitable business. Mostly older people farming.

- 1970s. More cassava, maize and okra introduced, with decline of plantain and taro. Decline in soil fertility. Vegetables introduced, but not commercially.
- 1980-90s. Upsurge in production for market, including maize and cassava. 20 – 80% of the latter sold, 33 – 80% retained for home consumption. Vegetables increased greatly in importance, nearly all sold, although overall cassava was cited as being the most important crop, with tomato usually being ranked second. Soil fertility at its lowest, smaller farm sizes. More permanent cropping with rotations. Increased use of fertilizers and other agrochemicals by vegetable growers. More young farmers.

**Figure 3.1 Diagram representing some farming systems for which the occurrence in the peri-urban area appeared to be related to distance from the city centre.**




Darker shading indicates important or increasingly important, lighter or lack of shading indicates unimportant or declining in importance. Circles at approx. 10, 20 and 30 km radius from city centre. *Source:* Blake *et al* (1997a, p.83).



Although this knowledge was concerned with changes over time, effects may have been accelerated by urban pressures, but as villages surveyed fell within a narrow range of distances from Kumasi (16 to 25 km, all on main roads), the surveys stood little chance of picking up spatial trends. For example, trends in soil fertility in relation to distance from Kumasi could not be described.

The research team in KNRMP concluded that although there were trends in agricultural practice with distance from the city, there was no trend in constraints and the team could not identify specific peri-urban effects in constraints (Blake *et al*.,1997a, p. 57).

The Village Characterisation Survey showed that reduction in fallow length was related to proximity to the city. Fertilizers were rarely used on food staples, fallows being the main means of restoring soil fertility. Farmers claimed that the bush fallow system will operate, albeit with a low level of output, with a fallow period as short as two years. However, rather than then changing to continuously cropped systems, farmers either give up farming or look for land elsewhere (on a sharecrop or rental basis), so they could continue the bush fallow system. There seemed to be a marked reluctance to invest in soil improvement for staple crops, in contrast to the Kano close-settled zone (Harris, 1998).

In a series of concentric circles at 10, 20 and 30 km from the city, the KNRMP team described some major farming activities for which the occurrence in the peri-urban area appeared to be related to distance from the city centre. Tree crops and intensified cereal cropping systems increased with distance from Kumasi. Conversely, green maize (for selling as fresh cobs) and backyard farming increased closer to the city. Intensive poultry were most numerous in the 10 - 20 km belt, then the 0 - 10 km zone, and were fewest when > 20 km from the city (Figure 3.1).

Within the city, there were continuously cropped systems, mostly in valley bottoms, where vegetables, sugar cane and colocasia taro were grown, with some semi-perennials such as plantain and increasingly with perennials such as oil palm. These farmers, although farming on Kumasi Metropolitan Assembly land, believed that the land was undesirable for building development (too poorly drained or swampy), and that effectively they have security of tenure. This is the form of intensification that would be expected when population pressures increase (Boserup, 1965; Tiffen *et al*, 1994; Harris, 1998). The majority of these farmers were from other areas of Ghana.

In the 10 - 20 km zone, competition for land appeared to be most intense, and change in use of land most rapid. Apart from the commercial poultry units previously mentioned, intensive vegetable production was increasing. This was typically on small plots (< 0.5 ha), often farmed by in-migrants. There appeared to be a more entrepreneurial sector of the population consisting of young, male farmers who were engaging in vegetable growing and intensive poultry enterprises, often on rented land. The predominating traditional mixed cropping bush-fallow system was breaking down as fallow periods shortened.

On the peri-urban fringes (> 20 km), family farm holdings still predominated, few of which were > 2 or 3 ha, except for tree crop plantations. Cocoa was declining in importance whilst oil palm was increasing. Food cropping was conducted on a traditional bush fallow system, the average fallow period being four to six years. There was evidence of some intensification of cereals, with increased inputs of herbicides (atrazine on maize, bentazone on upland rice) and fertilizers. The team had not determined the origin and status of these progressive cereal farmers. However, the presence of food crop intensification indicated that lack of finance or knowledge was probably not the major constraint to intensification of food crops in the peri-urban interface. These particular stakeholders need to be more accurately characterised.

To highlight the unusual nature of the land use patterns around Kumasi, and the influence of urbanisation upon production systems, it is pertinent to contrast them with those described in a study funded by DFID (Scoones and Toulmin, 1999), in which the consequences of various farming systems on soil fertility were described. They reviewed, amongst many others, three studies of high rural population density with market-oriented farming systems. These were Tumbau in the Kano Close Settled Zone, northern NIgeria, Kisii near Kisumu, western Kenya, and Machakos, southern Kenya. It was concluded that broadly soil fertility in these agricultural systems was being maintained.

Factors common to the three sites were:

1. High population densities (800 $km^{-2}$ at Kisii, 36 to 383 $km^{-2}$ at Machakos and 223 $km^{-2}$ at Tumbau), leading to high labour availability either from families or for hire.
2. High livestock population densities, with good integration between livestock and crops (animals often used for draught or haulage, crop residues and fodder fed to livestock, and manure diligently collected and applied to fields). For this, some degree of stall feeding was necessary.
3. There was a low to moderate dependency upon external inputs: inorganic fertilizers being used at moderate levels (57 kg/ha at Kisii, < 50 kg/ha at Tumbau, no data for Machakos).
4. Trees were important components of the systems, for fodder, fuel wood, fruit and cash crops.
5. Grain legumes were an integral part of the system. At Tumbau, the contribution of nitrogen fixation from groundnut and cowpea varied from 0 to 37 kg N/ha, depending on cropping pattern (Harris, 1998).
6. High cropping intensity, with limited fallow or none at all.
7. Secure usufruct rights or title to land.
8. Good marketing opportunities for excess produce and cash crops.



There were also differences between the locations:

9. Annual rainfall differed greatly (1350 to 2050 mm at Kisii, 600 to 1200 mm at Machakos, 570 mm at Tumbau).
10. Soil at Kisii were deep, well drained volcanic of recent origin, fertile but with a tendency to fix phosphorus. At Machakos and Tumau, soils were alfisols of moderate fertility.
11. Main crops grown at Kisii were maize and beans, with smaller areas of sweet potato, finger millet and vegetables. Main cash crops were tea, pyrethrum, bananas, coffee and sugar cane. At Machakos the principal food crops were maize, beans, cowpea (*Vigna unguiculata*) and pigeon pea (*Cajanus cajan*), with vegetables (tomato, cabbage, kale (*Brassica oleracea*)) where conditions were suitable, and cotton and coffee (*Coffea arabica*) as cash crops. At Tumbau, the farming system was based on cereal and leguminous grain crops: millet (*Pennisetum typhoides*), sorghum (*Sorghum bicolor*), groundnut and cowpea, usually intercropped in a single season. Trees were retained in fields for fruit, edible leaves, silk cotton and firewood.

It is worth comparing the above examples with peri-urban Hubli-Dharwad and Kumasi. There was little evidence of a decline in productivity around Hubli-Dharwad (as opposed to a general stagnation or decline across Karnataka State, both rural and peri-urban (Satish Chandran, 1993)), and it is notable that many of the above contributory factors also pertained in the Hubli-Dharwad peri-urban interface, particularly 2, 3, 5, 6, 7, and 8 in the list above. The Hubli-Dharwad

PUI population density was 181 $km^{-2}$ in 1991, fairly high for a rural area, and labour intensive cropping systems were used (although farmers claimed that labour was not abundant, at least not at prices farmers were willing to pay). The Hubli-Dharwad PUI had a high cropping intensity (no fallows), high livestock numbers, a crop rotation based largely upon cereal and legume grains, but with few trees integrated into the farming system (maybe because cotton stalks were used as cooking fuel by the poor). At Tumbau, near Kano, farmers applied a mean of 4.3 t/ha of livestock manure annually to the holdings, although rates per field within a season varied from 0 to 17.5 t/ha (Harris, 1998). This was remarkably similar to the mean quantity applied on farms around Hubli-Dharwad (4.6 t/ha a year, Universities of Birmingham *et al*.,1999a).

It is believed that the Kumasi PUI also has a high population density (although there are no reliable recent figures), farms have a low dependency upon external inputs, and produce marketing opportunities appear to be good (but see below), but there the similarities end. The critical constraint to productivity is that secure usufruct rights have been eroded by illicit disposal of land for building plots, mostly without compensation. This situation was described by Boserup (1965, p. 91), 'When tribal chiefs manage to be confirmed as private owners of tribal land [*as has effectively occurred in Kumasi*: author's note] a breakdown of the whole tribal organization of investment may ensue…'. The reluctance of farmers to invest in building up soil fertility and applying other agricultural inputs is likely to be a direct consequence of their lack of security of access to cultivable land (Blake *et al.*, 1997a). This analysis appears to be somewhat at variance with the findings reported above (Kasanga, 1998, p.98), that farmers overwhelmingly stated that tenure was not their main constraint, but that lack of credit / finance and poor soil fertility were. The issue of land tenure is explored further in Chapter 6.

Markets were not well characterised, although ten 'market queens' (controllers) were interviewed (Adam, 1999a, p.9-10). It was found that non-perishable foodstuffs could come from great distances, from where lower units costs may prevail, or have other comparative advantages such as availability of larger tracts of land, better climate or soils, lower biotic stresses, cheaper labour. For example, the interviews showed that some maize was brought in to Kumasi market from Techiman, Brong Ahafo Region, yams from Ejura Kintampo, cassava from Greater Accra, millet and legumes from Northern, Upper East and Upper West Regions. However, quantities were not ascertained. Bulkier crops more suited to the local area such as plantain and cocoyams (xanthosoma taro) were supplied from within the peri-urban region. Evidence presented was anecdotal, and



incentives and disincentives to crop production due to marketing require further investigation.

There was also a much lower density of livestock (Chapter 4), particularly bovines due to tse-tse fly and absence of a tradition of keeping donkeys. Thus the availability of manure was low and practically all tillage and carriage of inputs were manual, all dramatically reducing productivity. The importance of draught for ploughs in short fallow systems was mentioned by Boserup (1965, p. 25). The absence of wheelbarrows and bicycles was also noticeable (R.M. Brook, personal observation); understandably, one of the constraints farmers cited for not using poultry manure was that it was arduous to transport. There was no integration between what livestock do exist and the cropping system, in that there was little attempt to incorporate manure into fields and neither were livestock systematically fed upon crop residues. One reason for the latter was that the diet of Kumasi was largely based upon tubers and plantains, which produce little by way of edible haulm, and sometimes these are toxic. Tubers and plantains are difficult to integrate with grain legumes, in contrast to cereals, so few legumes seem to be grown; if so, this reduces the opportunity to incorporate N-fixing crops into the system. Tubers and plantains also take up large quantities of K from the soil, which if not replenished eventually leads to deficiencies.

These factors all combined to lead to a production system starved of inputs, even the normal bush fallows. Evidence of this was the low yield of maize (Table 3.3), which is poor for a region with weakly bimodal 1,488 mm rainfall p.a. (CEDAR, 1999, p.11). Nutrients are being mined from the soil, one consequence of which was that crops have low resistance to pests and diseases. It is interesting to note that 20 km or more from Kumasi, farmers are intensifying production, particularly maize and rice. The application of herbicides is quite an unusual feature in small holder agriculture in Africa, and suggests that where farmers feel more secure about their continued access to land, they are prepared to invest in the productivity of their land. The renewed establishment of cocoa farms is further evidence of this. The hypothesis that there is a link between perception of secure access to land (even when no formal title is held) and willingness to invest in longer term farming enterprises needs to be tested.

**Table 3.3. Grain yields from poultry manure on maize demonstration plots around Kumasi.**

| | Yield in major wet season | Yield in minor wet season |
|---|---|---|
| Unmanured | 1714 kg/ha | 1333 kg/ha |
| Manured | 2571 kg/ha | 1809 kg/ha |

*Source:* Adam *et al.* (1999)

Further light can be shed upon the unusual constraints on production in peri-urban Kumasi by considering agriculture in urban areas. Strictly speaking this should be outside the remit of an investigation of the peri-urban system unless it impinges in some way upon peri-urban productivity or livelihoods. Although in Kumasi such effects were indirect at most, the KNRMP did consider agriculture in urban areas, and the contrasts are worth examining. Researchers found that there were two forms of urban cropping activity in Kumasi: backyard farming and agriculture 'in the gaps' (crop production on vacant, low lying land between urban developed zones).

Backyard crop production was examined in three contrasting residential areas of the city (Adam, 1999b, p.99-125), 30 plots in each being selected for study. The average age for backyard farmers was quite high, 42% being 50 years or older, and had been resident in the city on average for more than 24 years. 69% of respondents were Ashantis. Most had jobs within the city. 90% of backyards had plantain and 44% grew cassava. Additionally, 36% of houses grew an assortment of vegetables and fruit such as tomato, okro, chilli, aubergine and cabbage. 34% cultivated xanthosoma taro and only 11% grew maize. It is interesting to note that tree crops were important components of backyard cropping systems, 44% having oil palm, 39% having mango, 36% having pawpaw (*Carica papaya*), 28% having avocado (*Persea americana*), 22% with orange (*Citrus sinensis*), 19% with apple (*Malus pumila*), 17% with guava (*Psidium guajava*) and 9% had cocoa. Note the existence of multiple responses. 23% of houses also kept some poultry and 8% had sheep or goats.

Only 4% of respondents depended upon urban agriculture as their sole means of livelihood, 75% of those respondents coming from a high density, low class residential area. The greatest number of respondents (91%) engaged in urban agriculture to supplement their incomes from other urban activities. 62% also cited the activity as a hobby. Houses that used public land for their activities constituted 12% of those surveyed, and 88% conducted their cultivation on private land. 69% of the properties were leasehold, 13% were occupied by squatters, 7% were rented



and 11% of respondents were caretakers of the property. Thus, it could be concluded that the great majority felt reasonably secure in their tenure, only 9% stating that insecurity of tenure was a constraint.

When asked about crop protection and other cultural practices, 84% said that they weeded their plots, 57% fenced them, 11% sprayed with agrochemicals, 33% watered their crops, but only 7% applied any fertilizer or manure (whereas approximately one quarter of houses had livestock of some form). When asked about crop residues, 31% said that they burned or disposed of them, 48% burned part of them and applied the rest to the crop, and only 13% responded that they used them for soil enrichment. None of the respondents used crop residues to feed livestock.

78% of households use their own labour to cultivate their plots, whilst 22% employed some hired labour. None grew crops solely for sale, but 20% sold at least part of their produce. 33% grew crops only for home consumption, and the remainder grew them for multiple reasons, including for giving as gifts. For those crops which were sold, the median annual income generated from sale of produce was ¢100,000 (£16)[1], which was very similar to the median financial input. For 86%, the annual value of outputs was < ¢200,000 (£33), and the mean contribution to the household food budget was < 5%. However, for every cedi invested, the owner estimated to get 4 cedi in return.

92% of urban farmers entered the activity upon their own initiative, but 80% said that they would appreciate some training, although only 24% had received any form of advice from extension agents. When asked about problems associated with backyard farming, 42% replied that biotic constraints were the most serious, whilst 12% cited poor or infertile soils. 53% would have liked more space. There seemed to be no discernible trends either into or away from particular kinds of cropping, numbers entering and leaving being roughly in balance.

The above kind of urban agriculture was rather different in nature from farming in the urban gaps. This was an extensive study (Agbenyega, 2000; Adam, 2000a) covering 59 respondents in three areas located between housing or industrial zones. Aerial digital photography was used to outline the plots on the Kumasi Geographical Information System (KUMINFO). The areas were generally low lying, often along water courses and rather swampy. Unlike the backyard farmers, the majority (81%) were non-Ashanti in origin, tended to be male (83%), and 66% were under 50 years of age. Educational level tended to be low (32% illiterate, 12% up to primary standard) and occupations were at the lower end of the income scale (27% labourers, 7% watchmen, 14% artisans, 22% farmers). 61% lived within 1 km of their cultivated plot. 25% were full-time cultivators.

Most of the land was owned by Government agencies, but nevertheless, 92% felt secure in their *de facto* tenure (*sensu lato*). Many had been farming these plots for 20 years or more and had experienced little or no interference from the true owners. 73% were growing trees on their land, often as boundary markers, which is one common sign of a feeling of security. 81% grew plantain or banana, 54% grew maize, 40% colocasia taro, 34% each of cassava, xanthosoma taro and sugar cane, 20% aubergines, 29% oil palm, 10% mango, and 22% grew other species of trees. 48% also kept poultry, 14% had fisheries, 9% had small ruminants, and another 9% had both poultry and small ruminants.

The predominant reason for cultivating in the urban gaps was to supplement household food supplies (41% giving this as the sole reason), 7% gave income and employment as a reason, and 49% said both food security and income were the reasons. 34% of respondents' families ate all the produce from their land. Thus, this form of agriculture seemed to play a more significant role in livelihoods than backyard farming.

When asked about inputs, 61% applied none at all, 7% applied manure, 14% applied fertilizers and manure, and 18% applied fertilizers and other agrochemicals. 83% left crop residues on their plots, and 12% burned them. Only 10% cited poor soil fertility as a constraint, the biggest cited problems being theft of produce (33%) and insufficient food (31%). In contrast to backyard and peri-urban farms, biotic constraints figured quite low in the ranking of constraints, only 12 % of cultivators citing these. On the other hand, 46% said that they required greater financial resources to increase production. In terms of intensity of production, these plots were no greater than peri-urban valley bottom farming around Kumasi, although in the latter cases the plots consisted mostly of annual cash crops (vegetables, with little or no perennial component). The contrasts of these two forms of urban crop production with peri-urban agriculture are revealing. In urban agriculture, the cultivators clearly believed that they had security of access to land. Interestingly, this did not manifest itself in investing in the fertility of soil (a common manifestation elsewhere), but in planting of economic tree species (another common sign of 'ownership'). In the instance of valley bottom cultivation in the urban gaps, in any case soil fertility would likely



be replenished through contamination of watercourses with sewage and periodic inundation during floods. In contrast, the decline in the perennial component in peri-urban agriculture is a common symptom of insecurity. The other symptoms were short term management approaches (mining of soil nutrients, growing of short duration crops and 'hit and run' horticulture enterprises).

The issue of soil fertility maintenance is worthy of further examination. It is interesting to see, even when access to land was secure (in both urban areas and on farms > 20 km from Kumasi), little attention was paid to maintaining fertility. On more distant farms, soil fertility was restored using the time honoured technique of bush fallowing. However, there seems to be a shortage of indigenous knowledge about soil fertility management apart from fallowing, which may have stemmed from the fairly recent decline in the effectiveness of this technique due to increasing pressure on land. Also, the lack of integration of livestock and crop production is worthy of note, in contrast to the three case studies from elsewhere in Africa described above (Scoones and Toulmin,1999) and around Hubli-Dharwad. This may be attributed to lack of experience of maintaining soil fertility using manures, and cultural issues surrounding the utilisation of waste materials. But whatever the reasons, the problem of low fertility in the peri-urban interface is likely to intensify as a constraint, but it is hard to see how this may be remedied when farmers feel that their usufructuary rights are insecure.

However, the hypothesis that in Kumasi, insecurity of land tenure discourages investment, may not get to the root of the matter. Whereas the blame is placed upon the nature of the traditional land management system, it may be that the operative factor is the speed and unpredictability with which changes in the possession of rights are implemented, thus determining the real or perceived risks involved in investments. The cases around Kumasi where young men, mostly non-indegenes, who intensively farm vegetables for sale in Kumasi on a “hit and run” basis, implies that they judge what remaining capacity can be extracted from the soil or what minimal inputs will keep it productive for profitable use in the short term.

A focus on speed and unpredictability raises questions of the importance of the rate of urbanisation as a factor in the maintenance for agriculture, tree growing and animal husbandry of land affected by the peri-urban interface. This may be a more basic determining factor than tenure, but one which produces substantially different opportunities for livelihood strategies of the poor as it works its way through varying systems of land tenure management. Research built on that already undertaken in Kumasi, Kano, Machakos and Kisii could possibly explain the differences observed in ways which would permit the formulation of land management strategy options which maintain and increase opportunities for the rural poor to fashion improved livelihood strategies when affected by urbanisation.

### *Characteristics of principal stakeholders in crop production*

Principal stakeholders in crop production were identified in (Blake *et al*.,1997a,; Kasanga, 1998). Food crop farmers were often women with family responsibilities, crops being sold to provide for their families. Some women engaged in trading, and sometimes finance from trade was used to pay for labour on the farms, but not, it appeared, for inputs to intensify agricultural production.

Male indigenes tended to be involved with tree crop farming, and some in vegetable farming. Other vegetable farmers were often young men working on rented land, often without family responsibilities. They may also engage in labouring jobs to make money, some of which is used for agrochemical inputs. In the short term, net flows of resources into vegetable farming may be positive, but one gap in knowledge is how long young men intend to stay in horticulture. The research team discerned an attitude in some men that they were using their enterprises to make money before moving to other occupations.

### *What is known about potential strategy options for interventions in crop production*

Following the Inception Phase of KNRMP, soil fertility was identified as the main abiotic constraint to crop production. Farmers were known to be aware of the problem, but remedial action was constrained by financial and tenurial issues It was considered that there was potential to use waste products from poultry farms to address the decline soil fertility. The rationale for conducting this study (Blake *et al.,*1997a, pp. 102-107) included. If poor farmers cannot afford fertilizer inputs, then manure or compost is their only means for improving soil fertility, once the fallowing system has broken down.

- The quantity of manure available locally would probably be insufficient to fertilise all the mixed food crop systems.
- Farmers of the more intensive vegetable cropping systems were considered to be better candidates for adoption of any recommendations that might ensue.



- It was recognised, however, that secure land use rights was a crucial factor in determining whether recommendation would be adopted. These land use rights become less secure with proximity to the city.

Having opted for examination of the soil fertility issue, on-station trials were conducted at the horticulture experimental site at the University of Science and Technology, Kumasi (Adam *et al*., 1999). On farm trials were conducted in three peri-urban villages, Duase, Apatrapa and Darko. A PRA exercise was conducted with 31 vegetable growing farmers (including 14 female farmers), who were asked to select those amongst their number who would participate in the trials. The farmers consistently reported that their main constraints were cost of agrochemical inputs and labour, and access to cash to finance them. Surveys have shown that soil ameliorants used by farmers in peri-urban Kumasi consist of about 57% poultry manure and 10% mineral fertilisers. Vegetable growing was considered to be laborious, as it involved land clearance, digging, mounding or ridging and weeding. Some cited increasing numbers of pests, particularly termites and grasshoppers. Most farmers, although aware of the potential of manure to enhance crop production, nevertheless did not use it. Even where poultry manure was available, some farmers considered that it was too heavy or bulky to transport.

Compared to Hubli-Dharwad, the lack of low technology transport (ox cart or even bicycle), and animal draught power imposes significant constraints to improving productivity of the farming system. In some locations, shortage of land was cited as a constraint, and an incentive for growing short duration vegetable crops. Other reasons cited for growing vegetable were quick financial returns and their importance in the household diet. Tomato cropping was usually conducted in the dry season, and therefore plots were usually close to permanent water courses.

Results presented in Table 3.4. were obtained from major rains experiments (Adam *et al*., 1999) and a report delivered by Quansah *et al*. (2000) to the final workshop of project KNRMP. However, there were several problems with the reports. The explanatory text in the workshop report did not match results presented in tables, so which was the true account could not be determined. For example, on-farm trials were reported as showing no significant treatment effects, but tabulated data were accompanied by superscripts that indicate otherwise. The researchers stated that due to a range of factors, for the major rains experiments (on station and on farm), yields were considerably below what could be expected from a well managed farm crop (normally 70 to 110 kg /100 m²). Therefore, the same must have applied for the minor rains experiment. Yields in the minor rains on-station trials were reported to be higher than for the on-station, major rains trial.

**Table 3.4. Results of tomato fertilization trials around Kumasi.**

| | Tomato (on station) Major rainy season cv. Petomech VF II | | Tomato (on farm). Major rainy season | Tomato (on station) Minor wet season cv. Power. | |
|---|---|---|---|---|---|
| Treatment | Fruit fresh weight (kg/100 m²) | % loss (disease, pests, cracked) | Fruit fresh weight (kg/100 m²) | Fruit fresh weight (kg/100 m²) | % loss (disease, pests, cracked) |
| No external input (control) | 38.4[bc] | 27.7 | 0.95[b] | 7.15 | 22 |
| Poultry manure @ 8 t/ha | 50.6[a] | 18.4 | 4.16[a] | 20.5 | 9.4 |
| [1] 60 kg/ha each of N, $P_2O_5$, $K_2O$ (as 15:15:15 basal ) + 50 kg/ha N & 57 kg/ha S (ammonium sulphate top dressing) | 45.6[ab] | 23 | 3.56[a] | 8.33 | 36.8 |
| Poultry manure + fertilizer at half above rates. | 29.6[c] | 28.8 | 4.57[a] | 16.0 | 19.6 |

Means within one column followed by the same superscript letter are not significantly different.

Columns without superscript letters indicate lack of significant treatment effects.

[1] Fertilizer samples were analysed at UST, and showed actual nutrient content differed greatly from those stated for the fertilizer. Unfortunately, in the report there were contradictions in the analysis, so all that can be concluded is that the experimenters could not be certain what quantities were being applied

*Source:* Adam *et al*. (1999, p.2).

From the results reported (Table 3.3), it is difficult to understand how this conclusion was reached, notwithstanding the fact that different cultivars were used for the two experiments. In all three trials, application of poultry manure resulted in fruit yields that did not differ significantly from the fertilizer treatment, but with lower losses. Losses did not appear to have been analysed statistically. Economic analyses of application of poultry manure and fertilizers were carried out for the on farm trials, but it was acknowledged that due to very low yields, the results meant little. Essentially, the experiments were failures; this reduced the usefulness of the research as a basis for generating new strategy options to the point where the experiments need to be repeated to obtain usable results.



One experiment with okro was conducted on-station, where again application of poultry manure produced yields as great as the fertilizer treatment, but not significantly different from the no-fertilizer control. This was an indication of high residual fertility of research station soils, as a consequence of which it is not possible to extend results to on farm conditions. Nutrient balance (calculated from fertilizer input, nutrient off-take in crops and nutrients remaining in soils after the season) studies were conducted, but as no methodology was advanced, it was not possible to comment upon the utility of the resul

Brief details on mucuna cover crop experiments were provided by Quansah (2000) on experiments in both seasons, and more extensively in NRI (2000b), for the first season. The PRA conducted by the soil fertility team had revealed that a number of farmers were familiar with green manuring and cover crops. Some reported using cowpea as a cover crop between rows of maize. Other NRSP funded work in Ghana (Forest Agriculture Interface System project in Brong-Ahafo on fallow management) has indicated that mucuna (*Mucuna pruriens* var *utilis*) cover crop can be used to increase the yield of maize on poor soils. In 1998-99, in the KNRM Project, experiments with dry season tomato were run on farms in three villages, examining the effects of mucuna and grass mulches, burned and not burned. In 1999-2000, the effects of fallow, mulch, soil cultivation and mucuna green manure on the yield of dry season tomato were studied. It was found that:

- Mucuna cover crop reduced afternoon soil temperatures and maintained higher soil moisture content, when compared with traditional slash and burn.
- Tomato yields were generally better on the mulched plots.
- Mucuna mulch provided cover for crickets, which caused significant plant losses.
- Farmers appreciated the positive effect of mulching on crop growth in the dry season.

NRI (2000b) presented interesting data on the soil ameliorant effects of mucuna mulch for the first season's research (1998-99), such as effect on soil temperature, soil moisture content, but once again the rigour of reporting reduced the value of the output, as no depths of recording point were mentioned (thus rendering comparisons with other work impossible). Soil nutrient content was measured, but results were rather variable. However, similarly to the poultry manure trials, tomato yields were an order of magnitude lower than farmers would normally expect from the crops. One reason was very poor crop establishment, partly due to cricket attack

In 1999-2000, experiments upon maize grown with mucuna green manure were conducted, and although the maize appeared to be showing greater vigour with the mucuna, once again crop establishment was very poor. It should be mentioned that in some parts of west Africa, live mulching with mucuna in both maize and upland rice has been spontaneously adopted and adapted by farmers with severely degraded soil, so the technology itself has significant potential.

The effect of municipal compost was also examined, at application rates of 10 kg/m² (equivalent to 100 t/ha) on the growth a yield of tomato and cabbage at two peri-urban farms sites was studied over two cropping seasons (CABI Bioscience, 1998). On-station experiments using composts at rates of 2, 5 and 10 kg/m² and an inorganic fertilizer treatment (50 kg/ha 15:15:15) were also conducted. These composts were obtained from Accra, and were made from human night soil and domestic refuse at the Accra Metropolitann Assembly composting plant. The hypothesis was that composts derived from municipal compost would help control pests and pathogens, with supporting evidence from other work (ibid, p. 3-4) suggesting that compounds released during decomposition controlled plant pathogens.

. However, in the event levels of pathogens were not high at the sites selected, so no effects were found, and the composts did not affect what few diseases did occur. The exception was tomato wilt (*Pseudomonas solanacearum*) in one season, but there was no beneficial effect of composts against this; in fact,



wilt was worse on compost treated than on untreated plots. There were significant effects upon growth and yield of tomato in the first season, possibly due to the very high rate of compost application. In the second cropping season, yields were low in all treatments due to ‘poor weather conditions and poor establishment’ (CABI Bioscience, 1998, p.2). However, in the first season, on-farm tomato yield from composted plots was equivalent to 0.6 -1.75 t/ha (Adam *et al.*, 1999, p.15), considerably lower than the yields of 7 to 11 t/ha that farmers considered to be the lower limits of profitability (ibid). The yields from nearby farmers' plots were not reported.

In the on-station experiment, in the first season it was found that for many of the parameters assessed, an application rate of 2 kg/m² was as effective as the higher rates of compost, and produced higher yields than inorganic fertilizer treatments and untreated plots. However, the differential between untreated and treated plots on-station were much smaller than in farmers' fields, indicating a high base level of fertility on the University research station (a not unusual phenomenon on developing country agricultural research stations, arising from regular applications of inorganic fertilizers). The second season experiments were afflicted with the same problems as the on-farm trials, and yields were so low that no useful information could be obtained.

Tests for coliform bacteria in compost were negative, indicating the temperatures reached during decomposition (80°C) killed all non-thermophilic bacteria, as well as fungal pathogens, nematodes, insects, their eggs and larvae. However, coliform bacteria were detected in soil later in the season, presumably from use of contaminated irrigation water.

It was concluded that application of municipally derived compost was effective in raising tomato and cabbage yields, but the economic aspects were not assessed. However, given the high rates used and the difficulties cited by farmers in transporting poultry manure, it is unlikely that farmers would adopt this compost as a soil amendment. However, the authors did point out that in Accra, the product was used by gardeners for landscaping and horticulture, and to a lesser extent by fruit growers. However, no further information on the wealth status or livelihood strategies of users was provided, so it was not possible to determine the likelihood of a similar Kumasi-derived product finding a market locally.

Composts were analysed for nutrient composition, and although there was a narrative, no tables of data were provided so a comparison with composts produced in Hubli-Dharwad was not possible.

From the evidence seen in CABI Bioscience (1998), Adam *et al*. (1999) and NRI (2000b) the knowledge of strategy options for land use and NR-based production systems interventions is inadequate. This was due in the main to the failure of field experiments in farmers' fields, and to high soil fertility levels at the UST experimental station which masked intended soil amendment effects. The exact reasons for failures of experiments were not identified in the reports (apart from generalities such as 'poor weather', 'disease problems', or 'poor establishment'). No information was provided on whether farmers' crops suffered the same problems, nor about yields that farmers were obtaining in adjacent plots, nor about who managed the experimental plots. Thus, it is not possible for future projects to learn from mistakes made.

### *What is known about dissemination of knowledge to the peri-urban poor*

PRA exercises showed that the most readily available organic soil amendment available in the PUI was poultry manure, with between 57% and 80% of poultry manure around Kumasi already being used (Blake *et al.*, 1997a;).

Kindness, 1999; NRI, 2000a, p.12).). PRAs conducted by GOAN (Ghana Organic Agriculture Network) indicate that farmers are aware of the yield advantages of poultry manure (claimed to be 30 to 50%). Field experiments (reported above) claimed that poultry manure could produce good vegetable yields at a cheaper cost than with inorganic fertilizers (although the evidence presented in Adam *et al.* (1999) failed to demonstrate this). Following this work, an extension guideline summary was produced and the Ministry of Food and Agriculture (MOFA) were approached to consider the possibilities of conducting an extension campaign based on the findings of the research (NRI, 2000a), despite the fact that experiments failed to demonstrate the anticipated benefits.

A one day training session was conducted with 49 extension officers, demonstrating recommended practical techniques for application. Following the training session, a project fact sheet was produced and distributed to 350 extension officers and the general public. Following this, extension officers in KMA and its contiguous districts held a total of 106 meetings, at which a total of 1582 people attended.



At these meetings, farmers were recruited to actively participate in the trial demonstration programme (which were biased towards the KMA district itself). Following the public meetings, the Regional Crops Specialist was invited by a local radio station to present the subject matter, at the end of which ten telephone calls had been received requesting further information.

Nineteen extension officers were actively involved in the follow up campaign, running training sessions in all the targeted villages. One of the villages was Assuyeboa, where farmers grow maize seed on contract, and who were already aware of the value of poultry manure. The intention had been to assess the farmers' knowledge, attitudes, skills and aspirations with regard to poultry manure before and after the campaign. However, the author reported (NRI, 2000b) that there were no records to show whether or not this happened. The regional crops specialist estimated, from follow up visits, that of those farmers who had applied poultry manure, only 40% had applied it correctly. NRI (2000b) exhibited some scepticism that farmers' knowledge had been enhanced as much as the extension officers claimed. Farmers were asked to evaluate poultry manure from a number of perspectives. The number of participants was impressive: n = 435; male = 342, female = 93, although the gender balance was a point of concern. However, it was not clear from the document whether all participants were also respondents. Therefore, here responses are ranked only, with a narrative indication of the value of the ranking exercise (with the exception of perceived effects of poultry manure, where the respondent figure (349) was given).

Perceived effects of poultry manure:

1. Improves crop vigour (92.0%)
2. Aids drought resistance (35.5%)
3. Results in big fruits or cobs (35.2%)
4. Increases yield (22.9%)
5. Cheaper than inorganic fertilizer (20.9%)

It was not clear why crop vigour was referred to separately from fruit size or yield effects; perhaps some respondents believed that the general term 'vigour' encompassed the idea of yield response. Clearly there were multiple responses, so for some respondents, yield or fruit size could have been a qualifier to vigour. The drought resistance effect was presumably linked to the higher organic matter levels that would follow application of poultry manure (which was mixed with sawdust bedding).

Disadvantages of poultry manure:

1. Difficult to transport/collect
2. Difficult to apply when wet
3. Bad smell
4. Bulky
5. Labour intensive

Nearly three times as many respondents cited difficulties of transport as any other constraints, so clearly this was a major factor. The lack of any transport intermediate between head loading and motorized vehicles (even wheelbarrows, bicycles or donkey carts) is the reason for this. As a consequence, any financial advantage of using poultry manure will have to take transport costs into account. In fact, the extension guidelines issued for the exercise (NRI, 2000b, p.12) tried to make a convincing case that even with transport costs, using poultry manure was more cost effective than using inorganic fertilizers. Clearly farmers did not agree with the economic analysis.

Perceived constraints to use of poultry manure:

1. Poor people need free or assisted transport
2. Transport costs high
3. Storage needed
4. Lack of access roads
5. Credit for poultry manure (for transport?)

Responses citing transport outnumbered other responses by nearly three times, and the other two constraints identified were linked to transport issues.

Farmers' proposed solutions to constraints were:

1. More trial groups needed
2. Should organise transport themselves
3. Poultry farmer dumps manure half way
4. Storage in trench or shed or covered with plastic sheet or palm fronds
5. Use group's power tiller for transport

Given the farmers' pre-occupation with transport of poultry manure, the first ranked response was very curious. The author of the report (NRI, 2000b) raised the possibility that this apparent desire for more experiments was possibly so that farmers could obtain more free (delivered) manure, rather than the altruistic motive of introducing it to other farmers. The author also suggested that some of the responses were those of the extension officers' rather than farmers. Overall, the author displayed little confidence in the objectivity of the extension officers involved.The final event was a workshop which brought together poultry and crop farmers to discuss problems of utilisation of poultry manure. 34 farmers (numbers not broken down into poultry and crop farmers), 31 MOFA staff, three researchers and a representative of GOAN were present. The participants split into groups to discuss various constraints. It was suggested that (no ranking):



- Farmers should form groups to cart manure in larger quantities;
- Farmer should site field close to poultry farms wherever possible;
- Poultry farmers could consider subsidizing the cost of transport (as disposal is a considerable problems for them);
- There is a Village Infrastructure Project that could fund power tiller or donkey carts, but some footpaths would need to upgraded to accommodate these.
- Storage on a mat of plantain leaves, and coverage of the heap with palm fronds.

Uncertainly about objectivity of extension officers notwithstanding (which could be addressed by training), the report provided some valuable knowledge. It demonstrated that MOFA could mount a significant extension initiative involving large numbers of farmers, which is useful for any future projects to know. The work also tested an approach for dissemination of results, and it would be valuable to follow up the participating farmers to determine how many become long term adopters, and reasons for non-adoption. At the time of reporting, following the extension exercise, 320 farmers from 800 targeted had tried using poultry manure. Also, after the initial trials with household composting (consisting of household waste, poultry manure and wood ash), one year later there were 30 farmers still making and using the compost.

Note

[1] February 2000 exchange rate: £1.00 = 6,000 cedi (¢).