DEPARTMENT FOR INTERNATIONAL DEVELOPMENT

STRATEGY FOR RESEARCH ON RENEWABLE NATURAL RESOURCES

NATURAL RESOURCES SYSTEMS PROGRAMME

FINAL TECHNICAL REPORT

DFID Project Number

R7867

Project Title

Filling gaps in knowledge about the peri-urban interface around Hubli-Dharwad

Project Leader

Dr R. M. Brook

Organisation

School of Agricultural and Forest Sciences,
University of Wales Bangor,
Bangor, Gwynedd,
LL57 2UW.

NRSP Production System *Date*

Peri-Urban Interface **15 March 2002**

Research team

Dr Robert M Brook, Project leader, School of Agricultural and Forest Sciences, University of Wales, Bangor

Paul Smith, Andrew Packwood, Martin Hollingham, Karen Hillyer, Roger Cratchley
Centre for Arid Zone Studies, University of Wales, Bangor

Dr Fiona Nunan, International Development Dept., School of Public Policy, University of Birmingham

Dr C.S. Hunshal, India project co-ordinator, Dept. of Agronomy, University of Agricultural Sciences, Dharwad
Dr Anasuya Patil, Dept. of Extension, University of Agricultural Sciences, Dharwad
Dr J. A. Mulla, Dept. of Livestock Husbandry, University of Agricultural Sciences, Dharwad
Dr B. Basavraj, Dept. of Soil Science, University of Agricultural Sciences, Dharwad

K. Shinde and S. G. Joshi, SDM College of Engineering and Technology, Dharwad

Dr Prakash Bhat, BAIF Development Research Foundation, Dharwad

Research assistants

Dr. P. T. Goroji,
Dr. A.V. Gaddi,
Dr. G. Bhuvaneshwari,
Dr. S. R. Salakinkop,
Dr Patil,
All working at University of Agricultural Sciences, Dharwad. Participated in crop and soil, marketing and livelihood strategy surveys.

A. M. Nitturkar, working at BAIF Development Research Foundation, Dharwad. Conducted livestock surveys.

Abbreviations used in Final Technical Report

APMC	Agricultural produce Marketing Corporation
BH	Bore hole
BIS	Bureau of Indian Standards
DfID	Department for International Development
GIS	Geographical Information System
GPS	Global Positioning System
HDMC	Hubli-Dharwad Municipal Corporation
HP	Hand pump
IPM	Integrated pest management
KSPCB	Kanataka State Pollution Control Board
MPLAAS	Maximum Permissible Limits in the Absence of an Alternative Source
NGO	Non-government organsaition
NRM	Natural Resource Management
NRSP	Natural Resource Systems Programme
OECD	Organisation for Economic Cooperation and Development
OVI	Objectively verifiable indicator
PRA	Participatory Rural Appraisal
PUI	Peri-Urban Interface
PWS	Private Water Supply
TDS	Total dissolved solids
TI	Target institution (typically a government line department)
UAS	University of Agricultural Sciences, Dharwad

Vernacular and scientific names or organisms referred to in Final Technical Report

English vernacular	Scientific	name	Var.	Other names
Amaranthus	*Amaranthus*	*virdis*		
Arecanut	*Areca*	*catechu*		
Aubergine	*Solanum*	*melongena*		Brinjal, eggplant, aubergine
Banana	*Musa*	Spp.		
Beetroot	*Beta*	*vulgaris*		
Brinjal	*Solanum*	*melongena*		
Buffalo	*Bos*	*bubalis*		
Cabbage	*Brassica*	*oleracea*	*capitata*	
Capsicum	*Capsicum*	*annum*	*grossum*	Bell pepper, sweet pepper
Cashew	*Anacardium*	*occidentale*		
Cauliflower	*Brassica*	*oleracea*	*botrytis*	
Chickpea	*Cicer*	*arietinum*		Bengal gram
Chilli	*Capsicum*	*annum*	*acuminatum*	
Clusterbean	*Cymopsis*	*tetragonaloba*		
Coconut	*Cocos*	*nucifera*		
Coriander	*Coriandrum*	*sativum*		
Hybrid Cotton	*Gossypium*	*herbaceum*		
Cotton	*Gossypium*	*hirsutam,*		
Cow	*Bos*	*indicus*		
Cucumber	*Cucumis*	*sativus*		
Curry leaf	*Murraya*	*koenigii*		
Eucalyptus	*Eucalyptus*	*citriodora*		Nilgiri
Eucalyptus	*Eucalyptus*	*tereticornis*		Nilgiri
Fenugreek	*Trigonella*	*foenumgraecum*		Menthi
Casuarina	*Casuarina*	*equisitifolia*		Galimara
Goat	*Capra*	*hircus*		
Mung bean	*Vigna*	*radiata*		Greengram
Groundnut	*Arachis*	*hypogaea*		
Guava	*Psidium*	*guajava*		
Horsegram	*Mycrotiloma*	*unifloris*		
Kale	*Brassica*	*oleracea*	*acephala*	
Khol rabi	*Brassica*	*oleracea*	*gongylodes*	Knol khol
Lemon	*Citrus*	*limon*		Nimbu
Lime	*Citrus*	*aurantifolia*		
Maize	*Zea*	*mays*		
Mango	*Mangifera*	*indica*		
Mulberry	*Morus*	*Alba*		
Napier grass	*Pennisetum*	*purpureum*		
Neem	*Azadirachta*	*indica*		
Niger	*Guizotia*	*abyssinica*		
Okra	*Abelmoschus*	*esculentis*		Bhendi, ladies finger
Onion	*Allium*	*cepa*		
Rice	*Oryza*	*sativa*		
Spinach	*Spinacia*	*oleracea*		Palak
Pea	*Pisum*	*sativum*		
Pomegranate	*Punica*	*granatum*		
Radish	*Raphanus*	*sativus*		

Ramphal	*Annona*	*reticulata*	
Ridgegourd	*Luffa*	*acutangula*	
Safflower	*Carthamus*	*tinctorius*	
Sapota	*Achras*	*zapota*	Sapodilla
Little millet	*Panicum*	*miliare*	Savi
Shepu	*Peucedanum*	*graveolens*	
Sorghum	*Sorghum*	*bicolor*	Jowar
Sugarcane	*Saccharum*	*officinarum*	
Sunhemp	*Crotalaria*	*juncea*	
Tamarind	*Tamarindus*	*indica*	
Teak	*Tectona*	*grandis*	
Tomato	*Lycopersicon*	*esculentum*	
Wheat	*Triticum*	*aestivum*	

Contents

1. Executive summary

This section summarises the contribution of the project towards attainment of the NRSP purpose: 'Benefits for poor people in targeted countries generated by application of new knowledge to natural resources management in peri-urban production systems'.

This project has generated knowledge that is a considerable advance on that consolidated in project R7549 'Consolidation of existing knowledge in the peri-urban interface system'. Several postulated effects of urbanisation have been confirmed by this project. In summary the research findings are:

- Agriculture is still a very important activity around Hubli-Dharwad, even in built up suburbs.
- Soil type and rainfall vary significantly across the study area, and are major determinants of cropping systems. Farming systems are very diverse, particularly cropping patterns, and there is evidence of greater diversity in villages closer to the city than in those further away.
- Although staples are important, cash crops dominate, particularly grain legumes, fruit trees and, in villages close to the city, vegetables.
- Trends in pH, available N and available K (but not available P) along some transects which in the case of one transect could be attributable to nutrient mining of soils prior to them being converted to non-agricultural use, and in another to fertilization by sewage polluted waste water.
- Urban influence upon cropping systems can be detected in the belt of mango orchards to the west of Dharwad and sewage water irrigated vegetable and tree fruit crops to the south of Hubli.
- Irrigation with sewage polluted waste water is practised in several villages, particularly for production of summer vegetables. This enables farmers with small parcels of land to make a good living, but has significant health implications for the consumer and farmer. Few farmers are aware of the potential for integrated pest management to reduce the need for very heavy pesticide applications.
- Due to increasing demand from the city for milk, dairying activity is intensifying, particularly in villages close to the city. The greatest intensification is by landless households who find dairying an attractive alternative or supplementary livelihood strategy to agricultural labouring.
- New knowledge has been generated in the areas of the indicators of poverty and how urbanisation has affected livelihood strategies. Some diversification into livelihood strategies less dependent on natural resources was noted, such as working in the city.
- There is no evidence that the ratio of poor/very poor to medium/rich households varies according to distance from the city (up to 15km from city centre). Poor and very poor families have tended to diversify their livelihood strategies in response to opportunities afforded by the city.
- Evidence from the produce and land marketing studies suggests that Hubli is a greater economic force than Dharwad. Higher prices pertain for agricultural produce and for land around Hubli. However, for land transactions, there is not a simple relationship between distance from the city and prices, although a trend was detectable. Reasons for sale of land were not determined, although it was an objective.
- Just as cropping systems are very diverse, so are marketing systems. Stakeholders in the marketing chain were characterised for rice, milk, fruit and vegetables. In some villages, middlemen control the market for some produce, but in other villages middlemen are rarely used. Poor and very poor households market a much smaller proportion of their agricultural produce than wealthier families, tending to rate food security a higher priority than sales. However, there

is no evidence that poor households are any less integrated into the marketing system than wealthier families.

- Water table levels are falling in villages surrounding the city due to over-abstraction by borewells. Conversely, in the city water levels are rising due to leakage from the water reticulation system. Water from hand pumps and tanks in most of the villages was non-potable, but these are the sources of water for those poor with no other access to water. Water in the aquifer flows along fractures, and not radially from the city. There is evidence that sewage pollution from the city is contaminating wells to the north of Dharwad positioned along these fractures. The water supply issue in some villages requires serious attention.
- Integration of target institutions (other than research partners) was poorer than anticipated, but the more or less simultaneous execution of R7959 engaged them much more effectively. It is recognised now that a data heavy intensive research project such as R7867 is not attractive to TIs with the remit of extension, for example. However, several offices from government line departments and quasi-autonomous corporations did attend the final project workshop, indicating an interest in the knowledge generated if not the process of generating it.
- The local team presented the final workshop in its entirety in Kannada, the State language, and one has presented a paper arising from this project to an international conference in UK.
- Data are now routinely stored electronically, and databases are maintained by the local research team.

2. Background

The goal to which the project sought to contribute was *'Natural resources management strategies for peri-urban areas which benefit the poor developed and promoted'*. This project, along with NRSP funded peri-urban interface projects in Kumasi and Kolkata (Calcutta) was designed to address the following aspects of this goal.

1. Natural resource based systems need to be understood before they can be managed effectively. This is particularly so in the peri-urban interface (PUI) where change is rapid in terms of both physical development (urban expansion) and livelihoods as people seek to adapt to survive or to take advantage of new opportunities which arise.
2. Before they can benefit from new natural resources management (NRM) strategies developed by projects, the peri-urban poor need to be identified and their livelihood strategies characterised.
3. Promotion has to occur at several scales, both spatially and temporally: spatially; within the village and its locality, which can be managed by the research team; in non-project areas around the city, which needs the co-operation of government line departments such as the local extension services; wider afield, which can be achieved through media at the regional or state level; and internationally through conventional academic dissemination routes and by DfID. The temporal aspect refers to benefits generated being sustained beyond the life of the programme. This implies changes in attitudes of government line departments, particularly among those that develop policies and enact regulations, if these are considered to be inadequate for managing natural resources in the peri-urban interface and if they are inherently biased towards the wealthier and more educated sectors of the population.

This project sought to contribute to the above goal by addressing the important researchable constraint of the lack of knowledge about the PUI which was identified during the precursor project, R7549 'Consolidation of existing knowledge in the peri-urban interface system'. A consolidation of what was known about the PUI was considered to be necessary before the next step, the participatory development of plans of action with peri-urban stakeholders, could commence.

Questions addressed in the Knowledge Consolidation project were:

1. Are the major production systems in the PUI adequately characterised?

It was concluded that around Hubli-Dharwad at a descriptive level, cropping and livestock systems were reasonably well characterised, but data were available only at a course resolution which could not detect urbanisation effects. Soils were described at a large land unit scale only. Surface water supply was fairly well characterised, but little was known about underground water resources, access to may be limited for poorer people. It was concluded that there was inadequate knowledge to permit strategies for management of natural resources to be developed.

2. Are changes to these production systems that are driven by urban development adequately understood?

Prior to the commencement of DfID funded projects, although awareness of urban encroachment existed, the concept of a peri-urban interface in terms it being a zone of rapid change and of flows of resources, was unknown. Therefore, systematic spatial description, still less analysis, of cropping and livestock systems and soil resources was not available, and consequently there was no knowledge about changes driven by urban development. Due to uncontrolled abstraction of

groundwater by tubewells (including requirements for urban industries), the water table was believed to be falling, but that remained to be verified. It was not known whether nor to what extent the poor were disproportionately affected by any changes in access to water. It was concluded that such changes needed to be understood if future projects were to be accurately targeted at pertinent issues.

3. Is the characterisation of the principal stakeholders in the PUI land use and natural resource based production systems adequate?

It was concluded that for one sector, the waste management and utilisation stream, stakeholders had been well characterised, and the principal stakeholders in the planning process were known. Researchers were aware of the lack of co-ordination between agencies concerned with natural resource management in urban and rural areas. For other sectors, the knowledge was either absent or incomplete. Knowledge of the principal stakeholders and how they operate and interact is necessary for several strata: to correctly identify who should be the primary beneficiaries of subsequent projects; which target institutions are relevant to the natural resources issues being managed; and who are the opinion formers, policy makers and officials who enforce regulations affecting those who live and work in the PUI.

4. Have the livelihood strategies of poor households affected by the PUI been characterised?

Prior to the adoption of a poverty alleviation strategy by DfID in 1997, research had largely been focussed on increasing productivity of natural resource systems and mitigating environmental problems. Consequently, the Knowledge Consolidation project found that there was little explicit information on the level of poverty in the PUI, who the poor are and what their livelihood strategies are, although number of indicators that could be used to identify poor households were known. This is a significant gap in knowledge and it needs to be filled if NRM strategies which benefit the poor are to be developed.

5. Is the understanding of the effects of urban development upon the poor adequate?

Not only were the poor inadequately characterised, but the effects of change upon them due to urbanisation were unknown. Rakodi (1999) concluded that there had been little explicit work on the impact of peri-urban processes on household livelihood strategies, anywhere. Exactly which sectors of the peri-urban population had been most affected by urban expansion had not been systematically characterised, still less for women. For example, it was not known how those poorer PU dwellers with land adapt their farming systems in response to new opportunities or threats to their livelihoods, nor how their poverty affects their ability to take advantage of new opportunities. Many details of the operation of the land market were unclear, and whether the poor are particularly at risk to the temptation to liquidate this asset, and whether retaining land is an advantage or disadvantage to their longer term well-being. Most details of the livelihood strategies of the landless peri-urban poor were not known. There was some knowledge about how solid and liquid wastes are used by peri-urban farmers, but an analysis of their level of poverty and how this affects or is affected by access to such resources is unknown. It was concluded that the risk of having such significant gaps in knowledge is that any policies formulated by urban and district level institutions will be poorly targeted, and may further disadvantage the most vulnerable sector of the PU population. Furthermore, these gaps in knowledge are a significant constraint to the formulation of well targeted research proposals, and to the development of pro-poor policies.

6. Is the knowledge of strategy options for interventions in land use and production systems adequate?

It was concluded that in the local research institutions there was likely to be a significant body of knowledge on interventions which could be adapted to suit particular circumstances. Any research required on specific interventions was likely to be adaptive.

7. What is known about ways in which this knowledge on interventions can be more effectively transferred to the peri-urban poor?

If development of interventions was likely to be a matter of adapting existing knowledge to the circumstances of the PUI, promotion was likely to be more problematic. Up to point of the Knowledge Consolidation project, transfer of knowledge had largely been via farmers participating in the research or to those with direct contact with projects, and thus very limited. Experience indicated that official institutions were probably ineffective but nonetheless should be encouraged to participate, but given the much greater interaction between NGOs and the poor, these would probably be the most strategic collaborators for effective transfer of knowledge.

It is concluded that significant gaps existed in knowledge about the peri-urban interface, particularly upon livelihood strategies of the poor, and that this was a constraint which had to be addressed before the NRSP PUI programme could advance to the next stage. This constituted the demand for the project which is the subject of this report.

3. Project Purpose

The Purpose for this project is: *'New knowledge base created to fill any critical gaps in existing knowledge bases for use in developing pro-poor plans of action in Hubli-Dharwad and its region'*.

As mentioned in the Background (Section 2) above, project R7549 identified a number of gaps in knowledge which if not filled would severely inhibit the development of plans of action which would specifically target the poor. 'Pro-poor' plans of action go beyond development of NRM strategies which benefit the poor, to starting the creation of an environment where the poor are themselves empowered to take action for themselves. It is recognised that a project which has the objective of filling critical gaps in knowledge would not be able to deliver such an environment as an output, but the inclusion of this phrase in the purpose looked forward to a stage where this could be achieved.

The knowledge base would primarily be for the purpose of informing stakeholders (initially researchers, but indirectly target institutions and primary beneficiaries) engaged in the development of plans of action for the management of natural resources, to facilitate accurate targeting of any interventions.

4. Outputs

Each of the outputs in the logical framework (Section 8) will be addressed in turn, and an assessment will be made of the extent to which each of the outputs has been achieved.

4.1 Better understanding of changes in the PUI driven by urban development: Specifically, changes in:

4.1.1. Cropping and livestock systems;

Before considering the understanding of changes in cropping and livestock systems driven by urban development, it is necessary to briefly put this study in context. Agriculture in the peri-urban interface, as anywhere else, is practised against a background of declining worldwide commodity prices for staple crops (Ashley & Maxwell, 2001) and changes in consumer demand.

Figure 1. Trends in global price for wheat.

Source: Home Grown Cereals Authority and OECD.

The above example illustrates the price trends for wheat, which has fallen by 50% in real terms since 1970, and the same is true for rice and all other staples. As India is increasingly exposed to world market prices (as part of the process loosely called 'globalisation'), this price trend is evident there. The relevance of this knowledge for this study is that any factors pertaining particularly in the PUI which exert upward pressure on variable costs of production, such as labour costs, are going to place farmers operating in that locality at more of a disadvantage than in more rural areas. Also, low commodity prices are good for poor consumers in urban areas but bad for producers, so this may act as a factor pushing people out of production of staple crops for sale. Additionally, cereal intake per capita in urban areas of India has stabilized at 130 kg p.a., and has declined in rural areas from 185 kg in 1980 to 160 kg in the late 1990s (Bhalla *et al.*, 1999). Conversely, consumption of milk and milk products has increased by 6% p.a. whereas annual population growth rate in the 1990s was 1.8%.

Another context relates to agricultural productivity in the State of Karnataka, where there has been a trend over at least the past two decades for crop yields to decline (NABARD, 2000: 4). In response to stagnating crop production in Karnataka a State Expert Committee was established to examine this (Satish Chandran, 1993). A range of reasons were given which need not be dwelt upon at this juncture; the purpose here is to establish a background against which peri-urban agriculture is operating, that of low and declining productivity. Both this and the downward pressure on commodity prices will influence the decisions about livelihood strategies that farmers make. Changes due to urbanisation may intensify pressures towards change.

Additionally, cropping patterns in Dharwad District are reported to be changing in favour of commercial crops, oilseeds, etc. (NABARD, 2000: 4). In view of declining prices for staple crops, this is not surprising.

The implications of the aforementioned pressures for change meant that the research had to distinguish between changes due to urbanisation from those due to other factors. It was necessary to distinguish 'signal' from 'noise'. As the trends described above are temporal and not spatial, the main devices used to aid the discrimination of 'signal' from 'noise' were linear transects (see FTR, Section 5 and Annex A, Section 2), the intention being that trends in villages near the city could be distinguished from those in villages about 10 km further away.

This project corroborated the finding from R6825 (the Hubli-Dharwad Baseline Study); that cropping systems are very diverse, revealed particularly when whole villages were sampled (Annex A, Figures 4 to 11). Factors determining crop and livestock systems were soil type (Annex A, Figure 1), rainfall (Annex A, Section 3.1, page A4), markets (Annex C) and probably also tradition was an influence, although the latter point is a matter of informed conjecture (but see Annex F, footnote 16). It is thus not possible to generalise about cropping systems around Hubli-Dharwad, which has implications for sampling in future research. Almost any village sampled would have a number of unusual or even unique characteristics. Thus, to an extent, this project can only be regarded as filling gaps in knowledge in those villages studied, but time and budget did not permit a more extensive sampling regime. However, despite the diversity, it is notable that staple crops are not an important use of land, particularly in the 'kharif' season (south west monsoon, when most rain falls), except in Mandihal where rice dominates. Most crops grown are arable cash crops, particularly pulses, cotton, chilli and orchard fruits. Commodity marketing surveys also found the same (Annex C, Tables 1 & 2).

Before examining the farming systems around Hubli-Dharwad more closely, it is first necessary to consider what factors might lead to change in the PUI that can be distinguished from the general trends described previously: in other words, what facets of urbanisation might cause change?

1. *Higher wage rates for manual labour in the city than for agricultural labour.* This makes it attractive for such workers to sell their labour to the highest bidder. Although it was the intention of the project to collect data on wage rates, due to time constraints it was not possible to do this systematically. However, some data on wages were collected (Annex B, Tables 7 & 13; Annex F, footnote 21), and more are presented in the final report of project R6825 (Universities of Birmingham *et al.*, 1998) and in Nunan (1999: 41, Tables 3.7 to 3.10). The effect of competition for wage rates is that there is a shortage of hired labour for farming activities around the city. Landowners cannot afford to raise wage levels because of the decreasing prices received for agricultural commodities. One response is to plant less labour demanding crops such as orchard fruits, particularly mango (Annex A, Figure 2) and sapota.

2. *Better marketing opportunities in the city compared to rural areas.* This influences the nature of agricultural enterprises (Annex C, Tables 1 & 2). Around Hubli-Dharwad. milk production is the best example of this (Annex A, Table 6).

3. *Access to resources not available in rural areas.* Examples are urban solid waste (characterised in Nunan, 1999), but use of this is declining, sewage polluted silt from a tank on the edge of Dharwad (Nunan, 1999: Table 2.1), and sewage contaminated waste water. The latter is dealt with in detail in the sewage irrigated farming systems component of this project (Annex F, Table 4, where responses by farmers in adapting their farming systems are described).

4. *Anthropogenic environmental degradation attributable to influence of the city.* Two examples are mining of clay in fields for making bricks (particularly prevalent in Kelageri) and quarrying for building an road stones (particularly in Mandihal). These result in loss of some land for farming. Data procured during the livelihood strategies component showed that in Mandihal there were 21 quarries occupying a total of 22.2ha, which is 5% of the cultivated land lost directly, but villagers complained that the dust created coats vegetation over a wider area (not determined). In Kelageri there were 23 operating brick kilns at the time of the survey. Area affected was not determined, but annual output of bricks from this village alone was 10 million, equivalent to 17,000m^3 of baked clay removed every year, or 0.6ha mined to a depth of 1m. The volume calculation does not allow for shrinkage during the baking process nor for shallower pits, but it does give a first order approximation of the scale of land lost to productive use every year by this means. Another form of exploitation of land is soil nutrient mining which might occur if farmers knew that their land was due to be built upon. Soil tests along the Kelageri to Mandihal transect provided some evidence that this might be occurring (Annex A, Section 3.1 and Table 1).

Cropping systems were analysed using two methods (Section 5, this FTR); sampling cropping systems every 100m and soil testing every 500m along four transects, and a complete survey of all cropping systems in eight case study villages located at either end of the four transects (for locations, see Figure 1 in Annex B).

Transects surveys of crops revealed the great diversity of farming systems and trends in soil fertility. The overall conclusions were:

- Soil type (Annex A, Figure 1) and rainfall are major determinants of cropping systems;
- There is great variability in cropping systems around Hubli-Dharwad, to the point where it is impossible to generalise;
- Trends in pH, available N and available K (but not available P) along some transects which in the case of one transect (Dharwad west) could be attributable to nutrient mining of soils prior to them being converted to non-agricultural use, and in another (Hubli south) to fertilization by sewage water (Tables 1 and 3 in Annex A).
- Urban influence upon cropping systems can be detected in the belt of mango orchards to the west of Dharwad and sewage water irrigated vegetable and tree fruit crops to the south of Hubli (Figures 2 and 3 in Annex A).

As far as is known, there has been no previous complete survey of cropping systems for several villages in a peri-urban interface, and the whole village cropping survey produced an unbiased sample at one point in time. The data supported the results obtained by the transect surveys, and were summarised as pie charts for the kharif

and 'rabi' (north west monsoon, yielding much less rainfall than the south west monsoon) seasons (Annex A, Figures 4 to 11).

Different crops dominated in different villages. For example, in Kelageri on the Dharwad west transect, co-dominant kharif cropping systems were those incorporating mango, and rice, which together accounted for half of the cultivated land area (Annex A, Figure 4). 'Grasses' was another category which was taken to refer to weedy scrub growing in worked out brick pits, and possibly abandoned farms (an unexpected phenomenon, where land owners have left their land to be grazed while they work in the city). In the rabi season, only 11.5% of the village land area was cultivated, indicating the great degree of summer fallowing. The livestock survey suggested that this might be linked to summer grazing of cattle and buffalo, but this needs to be verified. At the far end of that transect, rice (paddy) was dominant, but perennial crops (not just mango) were also important (Annex A, Figure 5). In the rabi season only 8.5% of the land area was cultivated due to the low water holding capacity of the soil, despite this village receiving the most rainfall of any of the case study villages.

Along the Dharwad north transect, variability of soils contributed to the very different cropping systems observed at either end of the transect. Dasanakoppa was the village with the most land cultivated in the kharif season (96% of total village area, the same as Shiraguppi) and in the rabi season (81.4%) permitted by the high water holding capacity of the soils. In the kharif, potato and groundnut, two important cash crops, dominated, whilst in the rabi sorghum, wheat and chickpea, which are crops well adapted to maturing on residual soil moisture on heavy clay soils, were co-dominant (Annex A, Figure 6). At the far end of the transect, greengram (mung bean) occupied over half the cultivated area in the kharif season. Soils are shallower here, with lower water holding capacity and as a consequence only 11.5% of the land area was cultivated in the rabi season, chickpea being dominant (Annex A, Figure 7).

Gabbur, at the Hubli end of the Hubli south transect, 'benefits' from access to irrigation with sewage water from Hire nalla (a natural water course which drains Hubli). Despite its proximity to Hubli and the fact that it lies within the boundary of Hubli Dharwad Municipal Corporation (HDMC), it retains many rural characteristics. Farming systems are described in Annex A (Figure 8) and in Annex F (in relation to use of sewage water).

The sewage irrigation system has characteristics unique to this practice. Three main categories of cropping system used sewage water irrigation: vegetable production, field crops and agroforestry. In all three, the irrigation method utilized along both the Dharwad and Hubli transects remains the same, that is an overland flow and furrow irrigation system (Annex F, Section 3).

Table 1 Spatial variation of predominant sewage irrigated cropping systems

Transect	Village	Distance	Cropping system
Dharwad	Madihal	2.0km	Vegetable production
	Govankoppa	5.4km	Field crops & vegetables
	Gongadikoppa	9.2km	Field crops & vegetables
	Maradagi	11.8km	Field crops & vegetables
Hubli	Bidnal	2.5km	Vegetable production
	Gabbur	8.9km	Field crops & vegetables
	Budarsingi	10.7km	Agroforestry
	Katnur	13.5km	Agroforestry

(Distance = length of the sewage nalla from city source to village including any meander).

Irrigation water is lifted by means of a centrifugal pump powered by either grid electricity or a diesel motor, and delivered under pressure to the highest field elevation (in Gabbur, sewage is also lifted from the Hubli Hospital drain pipe which is routed past the village) (Annex F, Plates 1 and 2). The irrigation pump and diesel motor together constitute the highest investment cost; therefore they are often housed in small brick buildings adjacent to the sewage nallas for security and protection against the elements. The distance from the sewage off-take to the actual outlet may reach up to 500m. From the outlet point the sewage flows under gravity along the furrows irrigating the crops. The opening and closing of the furrows is a precisely timed operation to ensure soils are not left waterlogged and ridges are not inundated, as there is no installed drainage in these soils. The frequency of irrigation is dependent on the crop type, soil type and rainfall amount, with irrigation increasing in the dry season and during erratic rainfall conditions (Hunshal *et al.* 1997). During the dry season vegetable crops are irrigated every two days and tree crops every ten days.

It was found that the cropping systems varied with distance from the city (Table 1), with vegetable production dominating close to the city in Bidnal and Madihal (not to be confused with Mandihal), the positions of which are presented in Appendices 1 and 2, Annex F.

Although farmers engaged in this practice because the waste water irrigation enabled crop production all year round in a semi-arid climate, farmers recognised three main problems associated with sewage irrigation:

- Profuse growth of weeds;
- 'Soil sickness' (decreased porosity of the soil leading to low infiltration rates;
- Greatly increased pest incidence on vegetables, particularly diamond back moth (*Plutella xylostella* L.) and the cotton boll worm (*Helicoverpa armigera*), which despite its English vernacular, is polyphagous.

The latter problem gave rise to another important issue, over-use of insecticides. These are predominantly organo-phosphates such as 'Endosulphan', which have a high mammalian toxicity. Larvae of both these insects have developed multiple pesticide resistance. In the absence of better advice, farmers have responded by increasing the frequency of pesticide application; weekly spraying is now a regular occurrence with some farmers spraying twice weekly. Farmers are also mixing pesticides prior to spraying, remedies advocated by the pesticide dealers who remain the main source of extension information. The net result is an increased risk of crop pesticide contamination and of farmers being exposed to pesticide poisoning (Hunshal *et al.*, 1997). Farmers reported that no health and safety advice was given by pesticide dealers, a fact clearly evident when visiting farms. Farmers were seen mixing concentrates and applying sprays with no vestige of protective clothing.

Scope for an alternative strategy of integrated pest management (IPM) was assessed, but few farmers or extension agents were aware of its existence, despite the existence of effective IPM strategies for both these pests.

Another health issue is coliform bacterial contamination of vegetables (Annex F, Table 3). This contamination was present on the exterior of the crops, as might be expected, but also internally. Cooking at high temperature would destroy this contamination, but significant risks remain if vegetables are eaten raw or under-cooked.

The Hire sewage nalla extends as far as Inamveerapur, the village located at the far end of the Hubli south transect, but by this stage so much abstraction has taken place upstream that irrigation is not available in the summer. Inamveerapur exhibited

the greatest diversity of cropping systems of any of the eight case study villages (Annex A, Figure 9).

Bidnal, at the Hubli end of the easterly transect, is the most urbanised of the villages, only 30% of the total land area being cultivated in the kharif season. Cash crops dominate: groundnut and a chilli – cotton intercropping system which is now widely practiced on the vertisols soils to the east of Hubli (Annex A, Figure 10). Very little land is cultivated in the rabi season (6.4%), and this is practically entirely sorghum, which has a duel use for grain and as a fodder crop for livestock in the urban dairies of Bidnal.

At the other end of that transect lies Shiraguppi, a village typical of the deep vertisol soils of the western edge of the Deccan Plateau: villages with large area and large fields; almost broadacre agriculture. 96% of the land area of the village is cultivated in the kharif season, when cropping is largely devoted to chilli – cotton intercropping, and a variant of it which includes an onion intercrop (Annex A, Figure 11). The cotton persists into the rabi season once onion and chilli have been harvested. Cotton was not counted when area cultivated afresh for the rabi season was calculated, so the figure of 14.7% of the land cultivated gives a false impression of extensive summer fallows. Crops grown exclusively in the rabi season are typical of crops maturing on residual moisture in vertisols: chickpea, wheat and another local system, wheat and safflower intercropping.

Studies of cropping systems in these eight villages strongly support the conclusions from the transect study: cropping systems are very diverse and generalising about farming systems around Hubli-Dharwad is not possible, in contrast to around Kumasi, where cropping systems are spatially much less variable (Nunan, 2001). A hypothesis concerning diversity of cropping enterprises that could be postulated would be that household farm enterprises closer to the city are more diverse than those further away due to easier access to markets. Table 2 sets out the Shannon – Weiner diversity index (see Annex B, Appendix 7 for an explanation of this) for the kharif and rabi seasons for ease of comparison. For the kharif season, the mean diversity nearer the city was only slightly greater. Comparisons along the same transect showed that for three, the nearer villages had more diverse cropping systems than the more distant, which supports the hypothesis. The exception was the Hubli south transect. In the rabi season, distant villages were much more diverse than near villages. A reason that could be advanced for this result is that in nearer villages there is a greater tendency to leave land as a summer fallow so that farmers can work in the nearby city, but this would need to be tested by asking the households concerned.

Table 2 Shannon – Weiner diversity index of cropping systems in eight project study villages for kharif and rabi seasons

Village		**Cropping season**	
Near villages	**Transect**	**Kharif**	**Rabi**
Kelageri	Dharwad west	2.36	0.76
Dasanakoppa	Dharwad north	1.64	1.18
Gabbur	Hubli south	2.13	0.58
Bidnal	Hubli east	1.61	0.45
Distant villages	**Mean of near villages**	**1.94**	**0.74**
Mandihal	Dharwad west	2.14	0.77
Pudakalkatti	Dharwad north	1.50	1.03

Inamveerapur	Hubli south	2.51	1.64
Shiraguppi	Hubli east	1.30	1.42
	Mean of distant villages	**1.86**	**1.21**

The project included a systematic study of livestock systems around the city. Livestock in India are an important factor in livelihood strategies; as a generalisation income from livestock in India accounts for 15 – 40% of total farm household earnings (Devendra and Thomas, 2002). Milk consumption is also increasing in India, from 34 million t in 1983 to 52 Mt in 1993 (Delgado et al., 1999); and although some of this can be accounted for by human population increase (2% p.a. during that period), nonetheless resources have to be found to maintain a greatly increased number of livestock. The livestock survey component was very extensive, with 361respondents being interviewed in the eight study villages and in two others south of Hubli (Section 5, this FTR). Wide separation of the villages enabled spatial analysis, and the survey also incorporated a temporal dimension. Unlike the cropping systems survey, which only sampled farming systems, the livestock survey stratified respondents into land holding classes (> 2ha = large; 1 - 2ha = medium; < 1ha = small, and landless). In rural areas, size of landholding is perceived as an indicator of wealth, as found in the livelihoods component (Annex B, Tables 2 a – d). The intention was to determine whether this was so for livestock farmers.

Table 6 in Annex A summarises data for numbers of livestock owned, milk and curd sales and milk consumption, broken down by village and land holding class. The results indicate a strong urban influence upon the dairy industry. The main factors driving change are:

- Hubli-Dharwad has a deficit in milk production and has to import it from neighbouring districts (NABARD, 2000: 35);
- Fresh milk is very perishable given the lack of refrigeration facilities in the villages where it is produced.

In response to these opportunities, in villages close to the city households are investing in buffalo. The substitution of cows by buffaloes is a trend across South Asia (Thomas *et al.*, 2002), but in villages closer to Hubli-Dharwad trend was stronger than in more distant villages. This is the preferred milking animal because of the high fat content of the milk (preferred by customers) and because it can be trained to let down milk upon demand and in specific quantities. This latter is a very useful attribute for those who milk their animals in front of the customer, which ensures freshness and freedom from adulteration. The Gowlies (Annex C, Section 2.1.1., Tables 28 & 29) specialise in this form of milk marketing, leading their animal(s) into the city in the morning to a specific location where customers visit them. Some also lead animals from house to house, milking upon demand.

In 2001, the mean number of buffalo per household in distant villages was 1.31, whilst in villages near the city it was 2.69. In 1990 the respective figures were 1.05 and 2.05. Buffalo numbers are increasing in both near and far villages, but more so nearer the city. When these mean data are broken down by land holding class and village, the response to opportunities presented by the city become clearer. For example, in Bidnal, in 2001 the largest number of buffalo were owned by the landless (4.0 per household), whilst the large land holding class owned a mean of 2.9 beasts. However, Bidnal is effectively a suburb of Hubli, extensively built up, so landlessness does not have the implications that this condition has in rural areas. In Gabbur and Kelageri, the two other villages falling within the HDMC boundary but still retaining substantial areas of farmland, numbers of buffalo per landless household were lower

than in Bidnal, but nevertheless numbers had more than doubled between 1990 and 2001.

In three of the distant villages, Channapur, Pudakalkatti and Shiraguppi, the landless had also increased their buffalo numbers over time. However, in Dasanakoppa, a village near Dharwad but with characteristics of a more remote location) number of buffalo owned by landless families had decreased over the same period. In the other three more distant villages, numbers of buffalo owned by the landless were either static or had decreased. The reasons for these trends in these villages were not determined. In Mandihal, in contrast to the other villages, more local cows are owned than buffalo, particularly by large and medium class farmers. Grazing is still freely available in this village, and the village employs a cowherd to look after the substantial herd, and cows may respond better to this form of management than buffalo.

Milk sales (Annex A, Table 6) disaggregated according to land holding class (largest first) for 2001 were 657, 689, 590 and 747 litres per annum, averaged across all ten villages. That the landless class should be selling more milk than any other class is revealing. Clearly, an animal that can be stall fed (for much of the season at least), and maybe grazed on field bunds if available, is a viable livelihood option for a landless family. For landless families in the three villages which fall within HDMC, the annual quantity of milk sold rose to 1,818 l/y, and if sold at a mean price of Rs9.1/l, this would generate a gross income per household of Rs16,543. In Bidnal, the landless on average sell even more, 4000 l/y. These results contrast with those from more rural environments in India (Thomas *et al.*, 2002), where the landless and those with little land (< 0.2ha) keep few ruminants per household, but thereafter the number of large ruminants increases with size of land holding, these changes being related to availability of crop residues and by-products. Results from the R7867 survey indicate that existence of a large (urban) market is sufficient incentive for landless dairy farmers to overcome their lack of natural capital by using financial capital to buy in fodder and perhaps social capital to negotiate grazing on summer fallows (see below).

It is more difficult for the distant villages to sell milk in the city (see Annex C, Section 2.1.1. for an analysis of the mechanisms of the milk market). Mandihal benefits from using Gowlies as middlemen who can transport milk quickly into Dharwad on motorcycles. Other village, such as Channapur, Varoor and Inamveerapur convert milk to less perishable curds before taking it to the city for sale.

Although dairying evidently provides an opportunity for landless households to make a living, sometimes quite a good one, data show that it is at the cost of family nutrition. Milk consumption figures reveal how landless households are under pressure to sell as much milk as possible. For the four land holding classes ranked from largest to landless, mean daily household milk consumption in 2001 was 2.39, 1.33, 0.97 and 0.67 litres per day.

Management of dairy herds also varied between villages. In Bidnal, most animals appear to be stall fed on bought or brought in fodder such as sorghum or maize stovers and hybrid napier grass. The other two villages falling within the HDMC boundary, Gabbur and Kelageri, still have substantial areas of farmland, and the dominant source of food for livestock is natural grazing. Here the proportion of land used for rabi cropping is low, and although there may be many reasons for this (such as more remunerative opportunities for work in the city, and rabi season yields being much lower than kharif crop yields), one possibility may be that fields are deliberately left fallow to allow summer grazing. As mentioned above, the other village where natural grazing is extensively practised is Mandihal.

In the remaining villages free or tethered grazing is less important. Here cattle and buffalo are mainly stall fed on forage sorghum and maize, rice straw and sometimes on concentrates. It is conjectured that this systems has two benefits. It facilitates dung collection for making pit compost, the farmers' most valued soil amendment, and as cash crops are important livelihood strategies in these villages, free grazing may be limited by the intensity of crop production (Annex A, page 25). In India, forage crops are usually restricted to irrigated farms (Devendra and Sevilla, 2002), and there is some evidence for this from Gabbur and Inamveerapur (Annex A, Figures 8 and 9) and Maradagi (see Annex F, Section 4.4 for an interesting example).

In conclusion, this output has achieved a much better understanding of crop and livestock systems around Hubli-Dharwad, and what changes are occurring as a consequence of urbanisation. Inevitably some questions remain, but overall this output has added very significantly to our knowledge.

4.1.2. Produce and land marketing systems and their operation

4.1.2.1. Produce marketing

What commodities are produced?

This component of the project incorporated some degree of stratification into wealth classes, although upon analysis it was decide to aggregate the wealth classes into poor plus very poor and medium plus rich. The sampling was much more limited than for the village level cropping systems studies, so some anomalies arose, such as the finding that Kelageri had a low diversity of crops (Annex C, bottom of page C3) in contract to the results reported in Annex A and in Table 2 above (this FTR). Nevertheless, results were generally in accord with the related livelihood strategy and farming system studies, and added a very useful dimension to the whole project.

Vegetable crops, which are either monsoon season crops or supported by irrigation in the summer season are particularly common in Gabbur and Bidnal and to a lesser degree Dasankoppa and Inamveerapur. It is noticeable that fruit tree crops really only appear in the surveys to any great extent in Inamveerapur and Dasankoppa (compare with Annex A). In terms of general patterns emerging from this survey, perhaps the most significant is that of the frequency of vegetable and milk production in four villages that lie closest to the urban centres: vegetables in Gabbur, Bidnal and Dasankoppa as well as milk in Gabbur, Bidnal and Kelageri. This dominance of perishable goods may be due to a number of factors:

1. Market access; although roads are generally good in the region, easier market access and the opportunities that arise from being close to the urban centres may make vegetable and milk production more attractive.
2. Agronomic; it is noticeable that the three 'vegetable villages' are located on the more productive black soils (clay rich, vertic), and all of them have access to irrigation with sewage water (see Annex F for a more detailed description of this practice) and so farmers can grow vegetables in the summer season, commanding high prices.
3. Economic; higher land prices closer to the urban centres (see Annex D and Table 3 below, this FTR) may force new entrants to agriculture to cultivate high input-high value crops, or labour saving crops such as fruit orchards (e.g. mangoes; a description of the labour contracting system is presented in R6825; Universities of Birmingham *et al*. (1998: 48) and in Paper 5 in the R6825 final workshop proceedings).

Prices received for commodities

A wide range of prices was found for the each of the commodities; in general there is a 300% range in prices that a farmer or seller could receive (Annex C, Table 3). This price range is most typically dependent on supply relationships with glut periods driving the price down although other factors such as quality of the goods and disposal routes are the other potential causes of differences in price. However, data on seasonal variations in prices were not obtained, but previous work has established that summer vegetables, for example, can fetch prices three times higher than in glut periods (Hunshal *et al.*, 1997). The commodities with the greatest range include cotton (Rs 300 – 2500 / quintal[1]; a 800% differential in price), onion (Rs 150 – 800/q; a 533% differential) and chilli (Rs 1000 – 5000/q; a 500 % differential). The inherent range in the value of crops does call into question the validity of applying the mean value of prices to commodities produced, but the alternative would be to disregard much of the data.

In an attempt to unravel some of the complexity in the price data, those for groundnuts and cotton were subjected to multiple regression analysis, because the sample sizes for these commodities were larger than for others. For cotton, an increase of one quintal in the quantity disposed leads to a Rs10 decrease in the price received per quintal (lower prices for bulk). The proximity to urban centre factor is positive, indicating that the price obtained by villages near to Hubli and Dharwad is greater than those further away (also borne out by data for milk products, Annex A), particularly for Bidnal and Dasankoppa. Shiraguppi and Inamveerapur, which are more distant villages, receive lower prices for cotton. Poorer farmers appear to receive more for their cotton. This maybe a function of their modes of disposal; all poor cotton farmers in Shiraguppi disposed of their crops to local retailers suggesting that farmers receive a greater price for this method of disposal.

Prices for groundnut decrease with increasing amounts sold, albeit only by Rs 0.25 / quintal. Those villages nearer to the urban centres receive higher prices than further villages. A dissimilarity with cotton is that those selling the crop within the villages receive less for their produce than those outside of the village. The reason for this disparity is unclear. There is a greater price paid for groundnuts in Hubli, with all villages closer to Hubli showing higher prices that those close to Dharwad. This may simply be a supply issue, or it may reflect the higher standards of living and ability to pay for household commodities in the Hubli area compared to the Dharwad catchment.

Economic importance of agriculture

Figure 1 in Annex C shows that value of agricultural outputs vary greatly between villages. In Mandihal (Rs117,352 average output per medium/rich farmer), agriculture is of very limited importance compared to the other seven villages, possibly because this is a quarrying village (see Annex B). However, milk is not mentioned as a commodity by the sample interviewed, but it is known from the livestock and livelihood strategies studies that milk is sold from there (Annex A, Table 6). On the other hand, the relatively nearby village, Dasankoppa shows the greatest agricultural output (Rs1,018,968 average). Of the other villages close to Dharwad, Kelageri (Rs536,815) with poorer soils has an average output approximately half that of Dasankoppa, and Pudakalkatti has even lower output (Rs387,642), approximately one third of Dasankoppa. In the villages close to Hubli, Shiraguppi, Gabbur and Bidnal all have output of similar orders, approximately Rs800,000, whereas Inamveerapur is approximately half that of the other three villages.

These figures give an indication of the relative importance of agriculture. The crops that are most economically important in the eight villages vary, as also found in the

[1] One quintal = 100 kg

cropping systems surveys (Annex A). In three of the villages, Shiraguppi, Dasankoppa and Bidnal, cotton is a very significant crop, and in Shiraguppi and Bidnal this is coupled with chilli, and guava is important in Inamveerapur. Another noticeable feature is the almost complete dominance of paddy in Mandihal, which equates to 94% of all agricultural output for medium and rich farmers and 56% for poor and very poor farmers (Annex C, Tables 8 to 10). Staples, whilst cultivated by the majority of farmers (Annex C, Table 1), are only dominant in Gabbur, Mandihal and Pudakalkatti.

Village level market analysis

To give some examples of the variability observed during this study, main features of marketing and disposal of crops in some of the case study villages will be summarised here. In Mandihal, rice (paddy) is the dominant crop, and it is noticeable that whilst approximately 40% of the crop is retained for home use, the remaining 60% is sold in the market place either through the village market or other village/town markets (Annex C, Tables 8 to 10). Furthermore, those farmers engaging in sales in markets other than their own markets are selling rice in the nearby village of Rampur rather than the more typical pattern of sales to the large urban centres. 69% of rice produced is either retained for home use or is sold within the village, further supporting the view that rice is important in the internal economy of the village and its immediate locality. This village exhibits a combination of typically rural (marketing of rice) and peri-urban characteristics (marketing of milk: Annex C, Tables 28 & 29, Figure 2).

Analysis of marketing in Shiraguppi reveals the width of the gulf between rich/medium households and the poor/very poor. Chilli and cotton are the most important crops for the livelihoods of rich and medium farmers (Annex C, Table 11), bengal gram (chickpea) being the only other significant contributor. For the 'typical' (or modal) farmer, the combined output is Rs675,000 p.a. (approximately £10,000) for those crops alone. In contrast, the sample of poor/very poor farmers did not produce any chickpea, and the value for cotton and chilli was only Rs30,000 (approximately £440); more than an order of magnitude difference.

Inamveerapur is characterised by fairly low agricultural output. However, there is a fairly diverse range of crops grown by rich and medium farmers (Annex C, Table 14), with tree fruit crops (with guava dominating) and vegetable accounting for 50% of average farmer output and 46% of typical farmer output. The high value commodity silk accounts for 10% of farmer output. For tree fruit crops, the farmer leases the standing crops to other farmers (who may be landless or from outside the village) who maintain the crop, guard it until ready and then harvest and sell on the crop. This is presumably a labour saving mechanism to allow the owner to enter into other income generating activities, as well as an investment for future income. A similar system was reported for mango orchards in project R6825. It is not clear why farmers in this village are engaging in tree crop cultivation to such an extent, issues such as increasing labour wage rates or reduced family labour alongside reduced prices received for annual crops are possibly leading to the push towards tree cultivation. It is also noticeable that in Inamveerapur, all the cotton, silk and menthi (fenugreek leaves) is sold to organisations and traders. In the case of silk, this is sold further afield in Bangalore, rather than in Hubli which is where the cotton and menthi leaves are sold. In general, tree crop investment and contract sale of annual crops seems to be an emerging pattern in certain villages, but not all.

In Dasankoppa a very wide range of staples and vegetables are grown, but only three: potato, sorghum and cotton are economically important (Annex C, Table 20). However, as indicated previously, the small-scale production of vegetables maybe a risk spreading activity. What is most surprising about Dasankoppa is that virtually all

the produce is reported to be sold through either the APMC (Agricultural Produce Marketing Corporation: see Annex C, Appendix C1) in Dharwad or through middlemen presumably for sale in Dharwad (Annex C, Table 21). This applies even for staples such as sorghum, which is normally produced for home consumption. This finding contrasts with Kelageri, the largest village which has a diverse marketing system. Dasankoppa is the smallest village with little prospect for sales within the village and hence disposal of crops is more likely to be outside the village. Middlemen tend to be creditors and support farmers by giving out loans, and as a consequence control prices, but also incorporate transport charges into the price that they pay for the commodity. Sales to the APMC and through middlemen tend to be more common in villages close to Hubli-Dharwad. The fact that this is happening with staples such as sorghum suggests that reduced transport costs nearer to the markets make this method more appealing to the middleman. An alternative reason could be that the opportunity cost of householders' time is greater in these villages and that they prefer not to incur the marketing costs of their goods (also see Annex C, page C29 for an analysis of the financial trade-offs between various methods of marketing).

Among rich and medium farmers in Gabbur, milk appears to be a relatively important commodity, and this is even more so amongst the poor and very poor wealth classes of the village (Annex C, Table 22), as also found in livestock surveys reported in Annex A. The values of milk reported for 'typical' farmers in Annex C, Table 23 (Rs 79,256 p.a.) corresponds well with data presented in Annex, Table 6, assuming a retail price of Rs 9.1/litre. However, this correspondence between surveys breaks down for Bidnal (Annex C, Tables 25 and 26), where milk seems unimportant. However, there was only one respondent from the poor/very poor category in that village. It should be borne in mind that the 'landless' in Bidnal are unlikely to be poor if they have invested heavily in dairying. The field researchers commented that it was very difficult to locate any poor farmers in Bidnal.

An important finding from this component of the project is that poor and very poor farmers sell a much smaller range of produce than wealthier farmers as a consequence of a less diverse agricultural base. This means that they are more exposed to risk of failure of one or more of their most important commodities.

Stakeholders in marketing systems

Stakeholders were characterised for marketing of milk, rice, vegetables and fruit (Annex C, Tables 28 to 31, Figures 2 to 4). Overall, there was a trend for increasing complexity of the marketing structure the less perishable the commodity. There is a very strong role of middlemen/APMC in the movement and sale of paddy and fruit and to a lesser extent vegetables. There is a general indication that the APMC is not entirely successful in delivering its stated objective of protecting producer prices, especially in those villages that do not have a particularly strong internal market. A singular example of the weakness of the APMC marketing system was observed in rice marketing in Mandihal. In this village, farmers prefer to sell rice in the village market at Rampur rather than through the APMC at Dharwad. These two locations are equidistant, and assuming that transport costs are similar it would seem to suggest that prices in the APMC are lower than the prices gained by village merchants in Rampur.

Transporting produce

Transport is an important factor in marketing. It is noticeable that there are a greater number of private vehicles such as tractors, auto-rickshaws and tempos in villages around Hubli compared to Dharwad (Annex C, Figure 5), further supporting the suggestion that the economy around Hubli is stronger than Dharwad (see land

prices, Annex D). Auto-rickshaws are found only in the closer villages, perhaps indicating the greater integration of these villages to the urban centres.

Transport costs of produce varied between Dharwad and Hubli. Around Dharwad, costs are similar for the two proximal villages, Kelageri and Dasankoppa, whereas from the distant village Pudakalkatti transport to Dharwad is four times the price. However, when comparing prices around Hubli, all villages have transport costs of the same order: around Rs 2 – 3 per 10kg basket. This lack of range in transport costs is possibly a function of not comparing like with like, although it may be a competition issue. With more vehicles being available in these Hubli associated villages, greater competition may force the price down. A feature of transportation is that whilst richer farmers seem to have a greater access to transportation facilities than the poorer farmers, those with transportation reported that they would perform a social good by helping out poorer farmers in transporting their produce. Whether this is truly a social good or whether poorer farmers had to offer a service in return is not mentioned in the surveys.

4.1.2.1. Land transactions

The purpose of the land transactions study was to locate areas of intense activity in terms of price per acre and number of transactions, and then to search for reasons for variations in land transactions. The study addressed the hypothesis that land transactions would be more numerous or sell for a higher price near the city, or both. The methodology is given in Section 5 of this FTR and a full account of the study is presented in Annex F.

As can be seen in Table 3, on average there have been more land transactions in Hubli takuk, around Hubli city, at a higher price per acre than in Dharwad taluk and more acres have been sold per village. This suggests that there has been more activity around Hubli, reflecting the more commercial nature of the city compared to Dharwad, and that land is in demand. Reasons for sales were not determined, although this was initially an aim and would have been highly desirable. A large body of data was collected on transaction in all the villages in Hubli and Dharwad taluka over five years so that 'hot spots' could be identified, but time to accomplish this precluded determining reason for sale as this was not given in the land sales registers. A transect approach would have been inadequate for identifying areas of intense transaction activity.

Table 3 Mean number of transactions, mean land price per acre and mean number of acres sold over the last five years per village

Year	Mean number of land transactions per village		Mean land price per acre		Mean number of acres sold per village	
	Dharwad	Hubli	Dharwad	Hubli	Dharwad	Hubli
1995-1996	3.39	4.86	29637	41766	10.39	18.12
1996-1997	3.32	5.07	34024	42358	12.73	19.11
1997-1998	4.05	6.09	40523	54814	13.71	21.13
1998-1999	3.24	4.18	38757	58613	10.88	13.76
1999-2000	3.48	6.35	40314	72325	11.44	19.29

Effect of distance and direction from Hubli and Dharwad

There is a relationship between distance and price of land per acre for both Hubli and Dharwad that is just significant, although stronger for Hubli than Dharwad. Although there is a relationship, it accounts for only 6.7% of the variation in land prices for the

Hubli villages and for 1.5% for Dharwad villages (Annex D, Figures 1 and 2). These data are presented as a map in Figure 3, Annex D.

The number of land transactions taking place is not, however, significantly affected by distance from Dharwad or Hubli. This is slightly surprising as it may be expected that land sales would be more numerous near the city than further away. Distance also does not significantly affect the number of acres sold for either Hubli or Dharwad.

The direction of the villages from Dharwad is a significant explanatory factor for the number of transactions, the number of acres sold and the average price per acre. For Hubli, however, the direction of the village does not significantly affect the price, though it does affect the number of transactions taking place and the number of acres sold. For Dharwad, the highest prices were found in the southeast, that is towards Hubli and falling within HDMC. The lowest prices, however, were found to the northeast, including Amminabhavi (10km), Kanakur (11km) and Marewad (9km). The distances of the villages towards the northeast from Dharwad are greater than those to the southeast, so there could be some impact of distance as well as direction.

The results for Hubli, where the number of transactions and acres sold are influenced by the direction, could have been skewed by one village, Hallyal, where on average over the five-year period, there were almost three times the number of transactions of the average of other villages, and significantly more acres sold. Hallyal lies just outside the HDMC boundary to the south east of Hubli, and is an area of fertile farmland. The highest prices were found to the north of Hubli, towards Dharwad, and fall within HDMC so land would have almost certainly be sold for building. Most of these villages are fairly close to Hubli, but the analysis was skewed by three transactions in 1999-00 in Keswapur, with 4 acres sold for an average of Rs681,000 per acre. The lowest prices were found in the southwest direction, in villages such as Channapur (12km) and Agrahartimmasagr (5km).

Other explanatory factors

The effect of the village in which the transaction took place and the year of the transaction were also explored. It was found that,

- The village does have a strong effect on the number of land transactions taking place. Characteristics of the village, therefore, influence the number of transactions and these need more investigation, but could include distance from a major road and soil type.
- The year of the land transaction is not significant in explaining the number of land transactions overall, although slight trends were noted and there are variations between years within villages. 1998-1999 appeared to have more transactions than other years, though reasons for this have yet to be identified.
- There is, however, a statistically significant effect of the year on the number of acres sold in the Hubli taluk villages only, though no relationship between year and price for either Hubli or Dharwad villages.

The main type of road that leads to the village was also determined using a district map as being national highway, bypass, state highway, district road or village road, and whether the village was at least 1km away from the main type of road (Annex D, Table 7).

For Dharwad villages, road type is a significant factor in explaining the number of transactions and number of acres sold, and a marginally significant factor in explaining the mean average price per acre. For Hubli villages road type is a significant explanatory factor for all three. The mean average prices for Dharwad and

Hubli were highest close to the national highway, whilst the highest mean number of acres sold was close to the bypass. Distance from the roads was important for some villages, with large differences in price for the national highway and district roads, compared with minor differences for the state highways. Other factors should be remembered, however, such as some villages close to the national highway may actually be so close to the city that there is little land left to sell, which may account for the low number of acres sold for Dharwad villages.

In conclusion, the analysis suggests that it is too simplistic to conclude that proximity to the city solely defines the value of the land. There are many other factors that also influence the value, including the direction of the village from the city and the main type of road that leads to the village. Other reasons may be the urgency of the land sale; if the vendor is desperate to sell, then a lower price may be accepted.

Distance from Hubli and Dharwad, and the direction of the village in relation to the city centres, do, however, provide some explanation for variations in price, though many other factors are also important. Villages between Hubli and Dharwad appear to have attracted the highest average prices per acre, as would be expected as this land is in high demand for housing and commercial uses. Prices for land in Hubli taluk are on average 47% higher than for Dharwad taluk, suggesting that Hubli city is economically stronger than Dharwad and therefore a more powerful force for change. Data collected as part of the produce marketing survey also suggest the same (Annex C, Section 1.5).

Further research would be useful, including examining variables such as why the land was sold, how much of the entire landholding does the land sold represent, and to what use is the land subsequently put. Finally, variation of land prices and the number of transactions within villages could be explored, as proximity to an internal village road could be significant, for example.

In conclusion, there were deficiencies in the methodology of the produce marketing survey (Annex C), but nevertheless enough knowledge was generated to be able to include marketing as a component in future action plan implementation projects. The land transaction was empirical and not very explanatory (in terms of reasons for sale), but as the dataset contains the names of transactors, reasons for sale and fate of land and vendors after sale can be determined in future.

4.1.3. Underground water resources, and access to them by the poor.

Variations in groundwater levels

Groundwater is contained in an upper, probably unconfined and a lower, confined or partially confined aquifer (Annex E, Section 3). These are described, in a regional context, by Subhash Chandra (1994) and, in the Hubli-Dharwar area, by S. Hegde (1991) and Bhat and Hegde (1997).

The general pattern of water level change with time reveals a marked contrast in behaviour before and after 1989 (Annex E, Section 4). Before 1989, most abstraction was from open wells with relatively few BHs. After 1989, BH construction increased markedly through Dharwad District by at least an order of magnitude (20993 BHs at the end of 1992 to depths of 50 to 100 m, according to Bhat) and by pre-monsoon, 1991 most monitoring BHs showed a marked decline in levels by 20m or more in both urban and rural areas. This was partly because of the relatively low rainfall of 1989, but comparison with the levels for 1985–86 when the rainfall was similar to 1989 indicates that the effect was mainly due to increased pumping from a greater number of BHs. In Byadagi, for example, the level declined to 52.5 m below ground level, pre-monsoon in 1991, compared with 17.1m pre-monsoon in 1977. By contrast, the situation in Dharwad urban area appears much better, the 1991 level being virtually the same as that in 1977, while in Hubli urban area the decline over the

same period was from 12.6 to 20.0m depth. However, Hubli and Dharwad were affected by the implementation of the surface water schemes at Neersagar and Malaprabha which led both to less reliance on groundwater and to artificial recharge through leakage. In other words, the general decline in water levels in Dharwad District caused by increased abstraction through boreholes and slightly reduced rainfall was not experienced in Hubli-Dharwad because of the artificial recharge from surface water schemes leakage and the reduced reliance on groundwater. In the years 1991-1992, significant increases in rainfall in most taluks of Dharwad District resulted in marked recoveries in water levels. For example, Byadagi recovered from the 1991 low of 52.5m to 17.3m depth pre-monsoon, 1993; Hirekerur from 40.7m to 20.75m depth. This illustrates that recharge to the fractured rock aquifer system is effective and takes place immediately after the SW monsoon season in general.

Village water supplies

Rural villages have several water supplies. The traditional supplies are hand dug wells mainly 4-5m wide and 15m deep, and tanks which are small water harvesting dams. These sources are still used, predominantly for watering animals and washing, however in some villages water from the tank is drunk as the villagers prefer the taste to groundwater as this tends to be salty. The water sources in the eight R7867 project villages were tested in 2001 as part of this study and found that the majority of drinking water supplies were not suitable for drinking mainly because the conductivity, total hardness or calcium concentrations were too high. It is generally reported that water levels in the wells are dropping. In Pudakalkatti it was reported that the dug wells still had water in them during the rabi season five years ago, but now (in 2001) tend to be dry by the end of the monsoon (Annex E, Section 4.6). Most villages have hand pumps, although access to them by the poor may be restricted (a finding from project R7959).

Water recharge in villages can be enhanced by the construction of new tanks, and the maintenance of existing tanks, if improved, would both raise water tables and improve water quality in rural areas. Village tanks are no longer the main direct water source for most villages and water would not be potable without treatment. Under used village tanks could be altered to improve groundwater recharge by drilling wells into the tank bed and filling them with gravel (Annex E, Section 10), which would improve those water supplies dependent on groundwater.

Village water quality

Out of 34 samples taken for this study, 24 were non-potable because of the presence of one or other parameter in access of the Maximum Permissible Limits in the Absence of an Alternative Source (MPLAAS) (BIS, 1991) (Annex E, Table 22). The parameters exceeding the limits are shown with bold letters in Annex E, Tables 24, 25 and 26.

Water from 14 HPs (hand pumps) out of 17 tested are non potable according to the MPLAAS, accounting for 82% (70%, without bacterial contamination being considered). The major parameters contributing to non portability in case of HPs are hardness (50%), bacterial contamination (23.5%) pH, turbidity, TDS, and calcium. This confirms earlier suspicions that ground water sources are becoming unsafe. When compared to the BIS (1991) Highest Desirable Limits for water, all samples fail on hardness, and calcium, 91% fail on TDS, and 50% on chloride.

Two open tanks samples show bacterial contamination due to open defecation surrounding the tanks, washing of animals and washing of clothes in the tanks. Bacteriological contamination is also observed in four HPs at Pudakalkatti and Dasanakoppa, which may be due to sewage pollution and/or improper well construction, insufficient drainage around the well and dirty taps.

Results from those borewells tested in 1988 and found to have high chloride levels (>400mg/l), an indicator of sewage pollution (Annex E, Table 26), reveals that these borewells also have high sulphate (>130mg/l), high hardness (>624mg/l) and high conductivities (>2000uS/cm). This suggests that the borewells in Narendra, Hosayellapur, Malapur, Old Hubli and Vivekanand College are polluted.

A contour map of chlorides (Annex E, Figure 40) suggests that there is a greater concentration of these in 1988 in rural areas, however the region between Hubli and Dharwad has low concentrations (<400 mg/l). This is similar to the trend predicted by the 2001 data. There is one place in Hubli and two in Dharwad which have high chloride concentrations; Old Hubli (1235 mg/l) has the highest concentration in Hubli and Nadrendra (717mg/l) and Hosayellapur (575 mg/l) in Dharwad taluk. These results indicate that borewells are likely to be contaminated with sewage pollution. Wells in Dharwad with concentrations below 400 mg/l and <250 mg/l are likely to be recharged with rain or water mains leakage.

The first three samples borewells around Dharwad happen to lie on a line in a NW – SE direction (Annex E, Figure 28), the same as the major fracture pattern and there is a probability that sewage pollution is leaking in this direction. If this is true then the villages of Gungargatti and Kotur may also be affected (not sampled during this project). The two polluted wells in Hubli have the same orientation as the Hire nalla suggesting that pollution may also be moving between these two points along a rock fracture.

It is concluded that pollution appears to be moving along recognized fractures and not moving out radially in an isotropic manner. S. Hegde (1991) found several borewells within the cities, connected by fractures, showing signs of sewage pollution, through a fall in pH values, a rise in conductivity values and chloride concentrations. This indicates little interconnectivity of fractures, which explains the variation of water quality between hand pumps even within the same village.

Whilst the high values for conductivity indicate borewells that are being polluted by sewage, low values indicate where recharge is occurring probably from water mains leakage. The values in 1988 for the wells around Hubli are similar to that predicted by contour maps of the 2001 data (Annex E, Figure 32). There is a definite trend for conductivity to increase away from Dharwad in 2001. This suggests that more recharge through leakage is occurring in Dharwad. There is also a trend for increased conductivity with distance from Hubli, with the exception of Inamveerapur, Bidnal and Gabbur which lie on the Hire nalla to the south of Hubli. Conductivity increases to the northwest and southeast and decreases to the northeast and the southwest.

Despite some serious pollution in the 1988 data set taken on average, in 2001 waters are more alkaline with a higher TDS and hardness. This suggests that water quality in rural areas is worse than that in the HDMC area, and / or since 1988 water quality has worsened. This supports the theory that as Hubli and Dharwad sit atop a ridge any rainfall that recharges will naturally flush solutes out of the aquifer under the city. The additional leakage from water mains and sewers will accelerate this process.

Another issue is pollution by pesticides. KSPCB is not fully aware of all the pesticides used in agriculture; however, another recent study which tested for five pesticides in North Karnataka found 20% of drinking water supplies contaminated with Endosulphan whilst the other pesticides were not detected (Annex E, Section 5.3.; Joshi, 2001). Annex F describes the scale of the use of Endosulphan in sewage irrigated agriculture. If this is reaching aquifers, then health implications extend beyond farmers applying the insecticide and consumers who eat the produce.

In conclusion, this component of the project has drawn together existing knowledge about water resources and had added new knowledge to that. However, little was found out about access of the poor to water supplies, although the following project R7959 has addressed this issue. The hypothesis that water use in the city was depleting aquifers in the PUI was rejected; if anything the reverse is the case. The cause of falling water tables in rural areas is over-abstraction within the village. An issue of concern is that pollution emanating from the city may be polluting wells in rural areas.

4.2. Knowledge of who the poor and very poor, and key stakeholders in the PUI are, along with the characteristics of their livelihood strategies and factors influencing them.

Key stakeholders are identified and discussed within the produce market component (Annex C, Section 2), as both these components shared the same data. The outputs from the livelihood strategies study will be discussed here. At the outset of the livelihood strategies component of this project, objectives were framed as a series of research questions (Annex B, Table 1), together with the associated research activities. These questions will be used as sub-section headings in this section of the FTR.

4.2.1. Who and where are the poor?

A considerable range and quality of “indicators” or “characteristics” were used by the village respondents in assigning households to one of four socio-economic categories (Annex B, Tables 2a to 2d). In this wealth ranking exercise, not all of these were clearly defined in the tables of perceived characteristics (Annex B, Table 3) but were evident from the 64 case study households studied and the results of a detailed study about indicators of well being in Mandihal (Annex B, Table 2e). The exercise showed that knowledge of the whole household situation is required for the process of wealth ranking rather than knowledge of a single set of a few indicators. Also noted was the fact that the characteristics of those households classified as poor and very poor varied between villages quite significantly.

Land ownership and occupation (‘work’ sense of the word) were the principal criteria used by the villagers describing the characteristics of the poor. The poor are often described as small landowners or landless labourers, but it was found that these criteria need further qualification in the PUI. Some landless have independent and profitable sources of income, for example dairy production (see Section 4.1.1. on livestock, this FTR), where in other situations small land owners would be struggling. Small land owners in turn could have profitable livelihood strategies if quality of land and a source of irrigation allowed them to produce intensive and remunerative crops such as summer vegetables. In villages with better agricultural potential, small land holders (1-2ha) could be classified as the medium class, whereas in others to be in medium class a household would need 10ha.

In the description of perceived characteristics of the poor, the landless or small land holders were often assumed by others to be agricultural labourers and other occupations, apart from construction and quarry labour, were rarely mentioned. In this livelihood analysis study it was found rather that the poor tended to rely on a far more diverse range of activities than this but did depend more significantly on others for employment (Annex B, Figure 2). However many landless or small land holders were found to have developed their own dairy or vegetable production enterprises for example, gaining advantages of independence.

In conclusion the poor and the poorest had the following characteristics, which include the criteria of land holding and occupation, but are qualified to be more specific than the commonly referred to “landless, small land holders and agricultural labourers”.

- Those with no or few productive assets, or assets that can be used for security (land, houses, cattle); low natural assets.
- Low skilled, low waged labourers; those more dependent on others for source of income, insecure casual work, seasonal; low human assets, but maybe taking advantage of social assets.
- Those who need diverse sources of income to earn a living throughout the year and/or to supplement income from main occupations; insecure financial assets.
- Households with high dependency ratio, and/or physical weaknesses are poorest, often having to rely on one source of income only; low human assets.
- Those who have incurred large debts to be paid back through provision of labour to the money lender; low financial assets.

It is concluded that the poor and very poor are characterised by deficiencies in a range of assets, not just financial.

In answer to the question, 'Where are the poor?' a comparison was made between the pairs of villages along the four transects. It was not possible to say that the relative extent of poverty is greater nearer to or further from the cities (Annex B, Table 5). Factors such as:

i) access to transport and markets and consequently the availability of better livelihood alternatives (physical assets), and;

ii) agricultural potential (natural assets),

were found to have a greater influence. It should be noted that between village comparisons were made by using wealth ranking. This method is comparative and so cannot provide data on absolute levels of poverty. Only in Mandihal were absolute levels of poverty determined, but not conducted elsewhere is it was too time consuming. However, if the general perception of what constitutes poverty is similar across many villages, then there are grounds for confidence in asserting that proximity to the city did not have an effect.

4.2.2. What are the main characteristics of livelihood strategies of the poor and the very poor?

These findings were derived from case studies of 32 poor and very poor households in the eight case study villages. Livelihood activities of the poor and very poor had the following characteristics:

- Livelihood strategies composed of small scale agricultural or livestock production, trading of products (craft, wood, dairy products, fruit or vegetables), labouring activities (in agriculture construction or commerce) or artisanal trades such as carpentry or plumbing (Annex B, Table 6, Figure 2).
- More of the poor category households were involved in activities with a greater level of independence and higher rates of income and greater diversity than the very poor group.
- The very poor had fewer employed in the better paid unskilled labouring jobs such as brick making and quarry labour than the poor, and less diverse sources of income, mostly because they had less capacity to carry out the more arduous work, fewer working members in the family and/or fewer alternatives due to reduced mobility.

Qualities of importance in livelihood options of poor and very poor were cited as being (Annex B, Section 4.3, Figures 3 & 4):

- **Regularity of work** (24%) and the importance of **tradition** (20%) were the advantages particularly attributed to agricultural labour, and artisanal occupations. This reflects the need for security of income over the actual level of income and also the fact that people feel secure in an activity where skills have been acquired since a young age. However, f**inancial advantage** (higher wages or profits) was also important (19%) with another 5% highlighting the benefits of receiving food as well as cash.
- An important benefit of brick and quarry labour, small livestock and especially dairy activities, was that of **"convenience of the work place" (6%) and "..market"(3%)**, particularly important to women, who are less mobile due to domestic duties and cultural restrictions. This latter is particularly true in Gabbur where women are discouraged from going to Hubli to retail milk, in contrast to women from Channapur (a finding from project R7959).
- "**Seasonality"** was an important factor, as poorer people, unless they have a more regular source of income depend on a patchwork of activities to enable them to work for the whole 12 months of the year.

The issue of tradition noted above was noted in other components of this project, for example in 'conformity' of farming systems within villages reported in Annex F, Section 4.1, footnote 16).

4.2.3 How does the change in the PUI affect livelihood strategies and options of the poor and the very poor?

In a study of the changes in livelihood activities of the 32 poor and very poor households, nearly twice as many changes were made in the nearer villages than the further villages (30, compared to 17), demonstrating a faster rate of change closer to the urban centres (Annex B, Table 11). However, there was no difference between the nearer and further villages in terms of diversity of livelihood strategies, as estimated by the Shannon – Weiner index (Annex B, Appendix 7).

21 of the poor interviewed changed away from agricultural labour to non agricultural unskilled employment, and another 24 moved into self employment, into commercial activities or new trades (11) or their own livestock (11) or agricultural (2) enterprises. About half (47%) of the changes made to livelihood strategies did not rely on the acquisition of capital or new skills, and achieved higher wages rates, whereas the other half (53%) tended to achieve higher levels of independence with their own enterprises, which would have required a degree of investment in land, animals or products to trade. This indicates that at least some the poor may be benefiting from urbanisation rather than becoming poorer. However, higher wage rates of those still relying on alternative labouring opportunities may not always result in improved family welfare, as there are indications of misuse of wages through alcoholism and also the cost of transport diminishes the benefits. The more independent enterprises such as dairying and contract management of orchards carry high input costs (fodder) and high risks (price crashes). The latter may nevertheless feel the benefits of improved social status.

Households closer to the city attributed a greater level of importance (20%) to construction and commercial labour than further villages (8%), where agricultural labour was found to hold greater (11% greater) importance, as were other locally available labouring activities (e.g. brick and quarry labour) and artisanal trades. This demonstrates a drain of labour away from agriculture in the nearer villages due to alternatives available in the city. Households further from the city prefer opportunities closer to home, reflecting the benefit of "Convenience of the work/ market place" referred to above in section 4.2.2.

Markets available for products differ with proximity to the cities, and this is reflected in the differing levels of importance attributed to various activities such as artisanal trades, flour mills and trading in milk and milk products (Annex B, Figures 6 & 7). Costs of marketing can be minimised in the nearer villages, where households attributed a greater level of importance (14% compared to 8%) to dairy production than further villages, despite the problem of accessing grazing and fodder (although see Annex A for a discussion of this point).

These moves away from agricultural labour partly reflect the expansion of the area under the city development programme in the early 1970s, and the resulting expansion in the construction industry, demonstrated in timelines for the quarry and brick making industries (Annex B, Tables 12 & 13). Also, agricultural production (as opposed to labouring) was considered to be equally important to the households in the villages nearer (3-6km) and further (12-18Km) from the cities (Annex B, Figures 6 & 7). These findings reinforce the conclusion that the move away from agricultural labour is the result of "a pull factor" created by increased alternatives, rather than "a push" resulting from a decline in agriculture.

The move of labour away from agriculture has had effects upon livelihoods of poor and very poor, two examples of which were found in the data collected;

i) Agricultural labourers who organise themselves into teams have negotiated higher rates of pay by taking on contracts to do field operations (Annex B, Table 14).

ii) There has been a decline in markets for trades such as blacksmithing and carpentry in the villages, as these were based on the production and repair of agricultural tools.

Many of the wealthier households have adapted to the decline in availability of labour with crop diversification, intensification and mechanisation.

Other changes made by the poor and very poor have been driven by:

- The need to adapt skills to a changing market e.g. blacksmithing to welding, carpentry for the tools market to carpentry for house construction, and free provision of festival music in villages to charging in neighbouring city areas;

and by opportunities:

- For training in new trades e.g., dental nursing, photography, plumbing and welding;
- For profitable agricultural production from small land areas presented by the availability of land for leasing, share cropping or buying, the relatively easy access to sewage irrigation in three of the eight villages studied and the market for vegetables and other cash crops;
- For dairy and livestock production presented by the secure urban market;
- From increased commercial activity, either self employed or employed.

4.2.4. Vulnerability context

Three factors identified which lead to increased vulnerability are:

1. Work related health hazards and alcoholism
2. Insecurity of agricultural production and fluctuating market prices
3. Debt

Work related health hazards and alcoholism result in reduction in family labour and skills and crippling debt from costs of health care. Examples found in the households studied highlight the risks of:

- Working in the cities: men tempted to drink their money and the risks of road accidents (victims being both bus passengers and roadside vendors of fruit).

- Disability and even death due to work related illnesses or accidents: respiratory problems resulting from dust from carpentry or quarry work and disability after an accident lifting heavy loads.
- Risks from sewage irrigation: not mentioned by any households involved in this activity, but described in Annex F.

There are several examples of women and children bearing the burden of the deaths or lost capacities of their husbands or fathers to earn an income or to cover debts incurred by high costs of health care. Children are taken out of school to work and contribute to the family livelihood, and women are left to provide for families on their own, or with the support of their extended families. Women and children are also more likely to be exposed to risks such as quarry dust, as they have limited alternatives for work as they are less mobile than men.

Insecurity of production and fluctuating market prices. Those poorer households dependent on agricultural labour for their main livelihood activities, and on the price of products such as orchard contractors and fruit sellers, may be more seriously affected by failed crops due to drought or price collapses due to gluts than the wealthy producers are as they have fewer resources with which to recover, often resorting to poorer livelihood options. Landowners can lease or sell land, and adopt more secure livelihood options, or borrow using their land as collateral.

The cases of debt found in the household studies are connected to the high costs of marriage ceremonies (one poor family said that Rs 50,000 is needed for an good, simple wedding ceremony), health care and crop/market failures. The problem of repaying loans has been met by selling or leasing land by both the wealthy and poor but the latter have also relied on the increased contribution of women and children to household income. High rates of suicide have been reported amongst landowners due to the problem of crop losses and debt, often based on the mortgaging of property.

Of the above three factors influencing vulnerability, only work related illnesses and risked can be considered impacts of urbanisation.

An assessment of whether this output has been achieved is that our knowledge of who the poor and very poor are, along with the characteristics of their livelihood strategies and factors influencing them has been advanced greatly by this study. The ability of the research team to identify and engage with the poor was significantly stronger at the end of the project than at the beginning. Knowledge of who the key stakeholders in the PUI are is largely restricted to some marketing chains. However, project R7959 has picked up where this project ended, and knowledge of key stakeholders and their roles has advanced considerably.

4.3. Target institutions recognise how PU change impinges upon livelihood strategies of the poor.

Amongst the TIs which operate in the PUI, at the start of the project very few had any awareness of the effects of urban expansion upon agricultural production, let alone its effects upon the poor. There is some degree of awareness of inadequacies in the effectiveness of some TIs; for example, ‘Changing cropping patterns in recent times have not been matched by suitable extension support’ (NABARD, 2000: vi), but this is a general comment that could apply to rural as much as to peri-urban areas.

The first step in creating awareness in TIs is engagement with them. This can be at a number of levels: initial contacts were for the purpose of procurement of information, and departments included the Public Works Department for maps of road networks, the National Highways Department for maps of the new by-pass, and Natural Resources Data Management Service for data at the district level. This latter body

was able later to let the project have digitised maps of village boundaries, which assisted greatly in the analysis of land transactions data.

However, this is not the same as engagement with TIs. The experience of the research team was that although the government line departments might be interested in the findings of the project, they were not interesting in participating in the research process. It was concluded that this was the wrong kind of project for such engagement, and considerably more success has been achieved with the Participatory Action Planning Project (R7959), as the TIs can see much more easily how the project's objectives relate to their own.

There was an opportunity to disseminate the findings of the project at the final workshop of the project on 11 September, 2001, held in the Public Works Dept. meeting hall. Table 4 presents a list of participants, which included nine representatives from target institutions.

Table 4 List of participants at final workshop of Gap Filling Project

Farmers' names	Research team and officials' names
Shankar Badni – Gabbur	Dr. Robert M. Brook University of Wales, Bangor, UK.
Shiddappa Badni- Gabbur	Dr. Fiona Nunan University of Birmingham, UK
Ramappa Meti- Gabbur	Sri. K. C. Shinde , Asst Prof, SDM College of Engg. Dharwad
Ningappa Sunagar-Gabbur	Dr. B. Basavaraj, Asst. Prof. UAS, Dharwad
Mallamma S. Talvar- Bidnal	N. Nagaraja , Asst. Horticultural Officer, Dharwad
Shivarudrappa M. Angodi -Dasankoppa	Anjanadevi T., Asst. Director of Fisheries, Dharwad
Chandrashekhar I. Angodi Dasankoppa	N. U. Bulla, BAIF, Dharwad
Shivangouda Kodagali-Mandihal	Dr. Anasuya T. Patil, Assoc. Prof.of Extn. UAS, Dharwad
Mrs Kallavva N. Sangolli- Mandihal	S. G. Joshi, Asst Prof. S.D.M. Collegeof Engg. Dharwad
Mrs Bhagirathi R. Siddvanavar – Mandihal	A. M. Nitturkar, BAIF, Dharwad
Mrs S. K. Kulkarni – Secretary GP, Mandihal	M. B. Patil, Environmental Officer, KMF, Dharwad
Mrs Najagumbi Nadaf – Shiraguppi	Dr. C. S. Hunshal, Prof.& Project Co-ordinator, UAS, Dharwad
Mrs Renuka Kale- Shirapuppi	S. L. Koshti, Suptd. Engineer, HDMC, Hubli
Basavannewwa Yeguppi- Shiraguppi	Dr. Rakesh S. Bangle, Veterinary Officer, Dharwad
Basavaraj V. Tirlapur- Narendra	V. S. Pavadashetti, I.D.S, Dharwad
Mrs. Gouramma. S. Kotur-Kotur	B. N. Gadag, Deputy Director, DIC, Dharwad
Basappa S. Maradagi- Kotur	Dr. Prakash Bhat, BAIF, Dharwad

Mrs Aparurabi .R. Mujanavar - Kotur	Munaralli Y.N, Range Forest Officer, Dharwad
Mrs Gourawwa K. Gabbur – Narendra	M. A.Alawandi, Agril. Officer (Watershed Development Department) Dharwad
Mrs Chinnawwa Targar – Narendra	I. M. Chachadi, Asst. Director, District Industrial Centre, Dharwad
D. Y. Malligawad- Mandihal	Dr. P. T. Goroji, RA, UAS, Dharwad
Laxman Mayappanavar	Dr. A.V. Gaddi, RA, UAS, Dharwad
Dharmgouda B. Patil- Inamveerapur	Dr. Bhuvaneshwari G. , RA, UAS, Dharwad
Basavaraj Y. Kale – Inamveerapur	Dr. S. R. Salakinkop, RA, UAS, Dharwad
Mrs Shantawwa Walikar – Inamveerapur	
Mrs Lalitawwa F. Madlli-Inamveerapur	
M.D. Melmari – Secretary , Narendra	
M.D. Javali-Secretary, GP, Kusugal, Ta: Hubli	
B.G. Kumbar, GP, Belagali, Hubli	
M. N. Tahasildar, Shiraguppi	

The entire proceedings were conducted in Kannada, the *lingua franca* of Karnataka, to make them more accessible to farmers. There were 32 participants from villages, and these out-numbered all the other participants.

It has to be concluded that the project did not achieve this output to any great extent. With the benefit of hindsight, this can be put down to the nature of the project. However, interaction with TIs is much stronger in the subsequent projects R7959 and R8084.

4.4. Local research team more strongly articulate how livelihoods are affected by urban development and are able to maintain digital database.

This output is concerned with capacity building in the local team, which was an important objective of the project in view of likely forthcoming projects.

During the course of the project there were two main occasions when the local research team could articulate how livelihoods are affected by urban development. One was the final workshop refereed to above, where Dr Anasuya Patil gave a presentation on the livelihood strategies component. The medium of communication was Kannada with no English translation, so no transcript is available for this report.

The second occasion was during the visit of Dr C. S. Hunshal, Indian Team Co-ordinator, to UK. At the DPU International Conference 'Rural – urban encounter: Managing the environment of the peri-urban interface' in November 2001, he presented a talk entitled 'Livelihood strategies in response to effects of urbanisation around Hubli-Dharwad' to an international audience.

Data from four of the surveys were collated in digital form: village level cropping systems, transect cropping systems, livestock systems and land transaction. Since then, data collected as part of a baseline survey for R8084 have been entered into an Access database designed by one of the local team members. A number of maps were either obtained in digital format or were digitised from paper maps, and kept in a GIS. Two members of the team in particular have proved to be adept at learning how to manipulate data in the GIS.

It can be concluded that this particular output has been achieved to a large extent, and the capacity building process continues in current projects.

5. Research Activities

Eight case study villages were selected according to their distance from the cities of Hubli and Dharwad along four transects upon which the programme of research focused (Figure 2). Some villages were selected from amongst their neighbours according to features of particular interest or impact, such as the presence of a particular industry (e.g. quarry). Otherwise, villages were selected to try to include as wide a range of variables that may affect livelihoods as possible, for example, population size, soil types and various facilities such as transport. Other sampling patterns were used for two components f the project. For the land transactions study, the whole of Dharwad and Hubli taluka were surveyed, and for the sewage irrigated farming systems study (Annex F) concentrated on transects running along two natural watercourses flowing from Dharwad and Hubli.

5.1. Farming systems surveys

5.1.1. Farm level: cropping and livestock systems and soil quality

Transects radiating out from Dharwad and Hubli were approximately 10km long, but the exact length was determined by the location of villages. Seven case study villages were surveyed between 20 January and 25 February, 2001 and Bidnal was surveyed between 15 and 20 June, 2001. Maps of each village were obtained from the Land Records Offices in Dharwad and Hubli. These mostly dated from the late 1980s, and were found to be quite out of date in many instances, but they did indicate village boundaries, the original survey numbers used and location of permanent features such as buildings and water bodies. Survey numbers did not necessarily correspond to ownership of one farmer only, as one survey number may contain several different farmers' fields. An example of one such map is given in Figure 3, for Mandihal village.

The original intention had been to talk to each landholder to determine land use in field managed by him/her, but some large villages had several hundred farmers, and in the time available this proved to be impossible. On the map in Figure 2, the initial attempts to sub-divide survey numbers into farms and fields can be seen, but it was soon abandoned as being impractical. There were also absentee farmers who were very difficult to meet, so in each village the Village Assistant (known locally as the 'Walikar') was used as a key informant. The Village Assistant proved to be a very useful source of knowledge due to his intimate knowledge of the village.

Cropping systems for both the 'kharif' (monsoon) and 'rabi' (post-monsoon) seasons were determined by talking to the farmer concerned with the Walikar, or in the event that the farmer was not available, to the Walikar alone. Data for each field were entered onto a recording sheet. Data collected were a description of cropping system in each field or sub-field, including different types of crop, whether inter-cropped, estimates of the area devoted to each different cropping pattern and the soil type.

5.1.2. Cropping systems along transects

The four transects were sampled at intervals of 100m to map spatial trends in land use systems from the edge of the built up area to a point approximately 10 km distant (in the event, at the nearest village). A waypoint was set with the global positioning system receiver (GPS) at the distant end of the transect, and the survey team then made their way towards it from the city end in as straight a line as tracks, field boundaries, and natural obstacles permitted. Land use systems (using the categories given on the data entry form) on either side of the transect were recorded. Actual positions of recording were recorded on the GPS. After each recording of the transect, they were plotted using Idrisi GIS software. Soil samples were taken at approximately 500 m intervals, a single, augered, 20 cm deep sample at each point.

5.1.3. Livestock survey

In ten peri-urban villages, a questionnaire survey was conducted with livestock owners to determine the status of livestock enterprise in those villages. Besides the eight case study villages selected for other components of the project, two additional villages were also surveyed for the livestock survey. These were Channapur (12km south west of Hubli, but the last 7km is a rough, unsurfaced road) due to its inclusion in the Action Planning project (R7959) and another village, Varoor, more distant from Hubli (15 km south along the National Highway 4).

Selection of respondents:

- The families in the village were stratified by categorizing them as big (>2 ha), small (1 – 2 ha), or marginal farmers (< 1 ha) and landless based on the basis of land holding of the family.
- A list of about 15-20 families of each category was prepared with the help of village accountant, gram panchayat secretary, village heads or key informants.
- The first available 8-10 respondents from each category were interviewed.
- The study was conducted by visiting each house and personally interviewing the head of family or key informant from the family.
- The number of respondents in each category was decided on the basis of proportion of families of that category in the village.
- Families having livestock of any type at present or at any time in past were considered for study. Families which never had livestock at any time were excluded from the sample.

5.1.4. Sewage irrigated farming systems

The survey of farming systems was conducted using semi-structured interviews and PRA techniques. The first phase consisted of an orientation and familiarisation survey of the farming systems located on the main Dharwad and Hubli sewage nallahs (natural watercourses) flowing from the two cities. This provided an opportunity to make initial contact with farmers thereby introducing the research project and identifying some of their main concerns, issues and constraints, in addition, the geographical extent to which sewage is used for irrigation was also gauged. The results of the preliminary survey were used to select the villages that would be targeted during the main survey, consideration being given to ensuring a wide geographical area was covered in an attempt to identify spatial patterns and trends (Annex F, Table 2). The second phase consisted of the main survey and incorporated semi-structured interviews; cropping calendars and transect walks (see Annex F, Appendix 1 for a copy of the interview guide). During the main survey a total of 25 farmers were interviewed. Most of the interviews took place in the farmers' fields.

5.1.5. Data entry and analysis

Data entry forms were created using MS Access 2000. Pilot forms were tested on limited surveys conducted in December 2000, and were modified where necessary. Sometimes it took two or three trial surveys before the research assistants were happy with the forms. Data sheets were used in the field, and data entered into Access upon return to the University.

Figure 2 here

Figure 3 here

The use of such a formal systems of data entry was justified because surveys were largely extractive in nature at this stage. The emphasis was upon collecting information that could answer the research questions set. Use of Access forced recording discipline upon the field teams, and given the time restrictions, this was considered to be necessary. The research team was also concerned that data should be stored in an internationally recognised database format so that subsequent researchers could make full use of it.

It has to be said that Access is a complex and sophisticated application, but simpler databases were eschewed in the interests of international standards. The UK researcher responsible for developing the data entry forms, Paul Smith, although very familiar with agricultural database management, nevertheless had to learn Access from scratch, which took time and restricted him to that task alone. The Access database was used for village level and transect cropping systems surveys and the livestock survey, and Excel was used for entering data from the land transactions survey. Other surveys were paper based and data had to be entered in Bangor prior to analysis.

Data were analysed by exporting them into a spreadsheet (MS Excel 2000). Excel has many powerful sorting and conditional data extraction functions which were utilised during analysis. However, there was no time to learn the even more powerful capabilities of Access for manipulating data, so it is likely that more information can be extracted from the database than is presented in this FTR. Statistical procedures were executed either in Excel 2000 or in Minitab v 13.

5.2. Produce and land market surveys systems and their operation;

5.2.1. Produce marketing

Villagers were interviewed and data collected on a questionnaire proforma (Annex C, Appendix C2). Respondents were stratified into the same wealth categories as used for the livelihoods study (Annex B), and the intention was that eight respondents per category would be interviewed. In the event, pressure of time resulted in variable numbers per category and village being interviewed. Each interview lasted 30 to 60 minutes. No repeat visits were made. Data were collected by Dr J. A. Mulla and a team of research assistants, and analysed by Dr J. C. Tuson in Bangor.

Rather than use the arithmetic mean to calculate average value of commodity output per farm, which is susceptible to skewing due to large numbers of zeros common in data of this nature, the ‘typical’, or modal, output was calculated instead.

Some methodological problems were encountered during the analytical in Bangor, by which time it was too late to rectify them. For example, in the questionnaire used by the enumerators, the two categories of middlemen and APMC were frequently treated as one mainly because the questionnaire sheet did not have enough response boxes. Data that might have legitimately belonged to one category were reported in both and it was not always possible to separate the two.

Another feature of the questionnaire is that there was little information about the proportion of the commodities that were sold initially, or retained for later sale, or whether storage meant storage for home use, for planting or for later sale. This deficiency meant that the storage and home use category were treated as one in the analysis.

5.2.2. Land markets

The purpose of the land market study was to identify the areas where there have been many land sales over the past few years and how prices have varied around

the twin-city, and to identify reasons for these variations. The study was particularly interested in exploring the potential effects of urbanisation on the number of land sales and prices around the city. The information derived from the study should enable further work to more fully explore impacts of land transactions on the livelihood strategies of the poor. This was not possible to follow through in detail in the time available.

Information was collected on all recorded land sales around Hubli and Dharwad, in villages within roughly a radius of 15km, between 1995 and 2000. The records of land sales are kept at the Hubli and Dharwad Land Registry Offices and both were visited on a number of occasions. The records are kept in handwritten ledgers and were copied out and then transferred into Excel spreadsheets. The information collected included the number of sales each year in each village, the price of the transaction and the number of acres sold. Details of land transactions in 61 villages in Dharwad taluka (sub-district) and 44 villages in Hubli taluka were recorded.

The land prices recorded, however, are not necessarily those that were actually paid. There are several incentives to report a lower amount to the Land Registry Offices. These include the payment of stamp duty which is calculated in relation to the guidance value given by Government, so if a higher price is paid, although the stamp duty would be no higher, the tax paid by the vendor would be greater if the actual, higher, price were reported. These incentives are, however, offset by the fact that if the land is resold in the future, prospective purchasers can consult the records and would question a significant difference in value, depending on how long ago the land was bought.

The names of the vendor and purchaser were also recorded, as well as the village or town in which they reside. This information was collected to enable further work to be conducted to generate a better understanding of why people are selling, to whom, and what livelihoods are replacing agriculture in cases where all the household's land has been sold. Finally, the survey numbers of the land sold were recorded to enable further fieldwork to see what use the land has subsequently been put to.

Data were also collected on potential explanatory variables, such as distance from Hubli and Dharwad and direction of village from the city. The main type of road leading to each village was also recorded from a district map to explore relationships between land sales and accessibility to the land.

5.3. Underground water resources and access to them.

This component was largely a desk study using existing source of information. It was supplemented by water quality analyses and visits to relevant government departments and university departments in Dharwad and Bangalore.

The analysis of water quality is derived from two principal studies. The first water quality survey was by S. Hegde (1991) as part of his PhD studies of the hydrogeology around Hubli and Dharwad. S. Hegde collected the water quality data in May 1988 from open wells and boreholes in Hubli and Dharwad and the land between them (Annex E, Figure 27, numbered points). The second study occurred in June 2001 as part of this project, S. Joshi collected (in June 2001) and analyzed samples from the major water sources within the R7867 study villages (Annex E, Figure 27, alphabetically numbered points). Unfortunately there are no common sampling points except for two open wells in Kelageri and Bidnal, which were sampled in both surveys.

The data from all 22 borewells collected by S. Hegde (1991) (Annex E, Table 26) and all the water quality parameters for hand pumps in 2001 (Annex E, Table 24) were separately contour plotted and compared. For the 2001 data set, data from the PWSs in Shiraguppi were used as there were no potable hand pumps and no hand pump

water quality data for Shiraguppi. The data were contour plotted (Annex E, Figures 29 - 43) using the contouring package SURFER 7 (Golden Software, 1999) using the minimum curvature gridding algorithm. The contour plots for the same parameters for both datasets were then compared to identify both spatial and temporal trends. Because the data sets cover different times and do not overlap very much spatially, it was difficult to identify if the changes in patterns are due to the effects of Hubli and Dharwad or reflect other changes over time, but this was attempted.

5.4. Livelihood strategy, stakeholder and poverty analysis surveys and access to water resources surveys conducted, using participatory approaches.

The methods and guidelines developed with the local research team to answer the research questions described in Section 4.2. above are presented in Appendix B1. Within each of the eight villages, eight households were selected from each of the four socio-economic groups determined by the wealth ranking procedure described an Annex B, Appendix B1. Semi-structured interviews were conducted with these households concerning their livelihood strategies and options. As mentioned in Section 4.1.3. above, the only aspect of this activity as listed in the logframe that ws not accomplished was the access to water resources survey.

5.5. Meetings and training activities

5.5.1. Regular meetings and joint surveys during project, and final stakeholder workshop held to increase awareness of peri-urban issues of NR management, and their poverty implications.

This was to be the main mechanism for achieving the output 'Target institutions recognise how PU change impinges upon livelihood strategies of the poor', but as explained in Section 4.3, neither regular meetings nor joint surveys were held. However, the final stakeholder workshop was held on 11 September, as also described in the same section. The focus of the workshop was on NRM in the PUI, and implications for poverty, so it can be assumed that awareness was raised, although no tests were applied to ascertain this.

5.5.2. Demonstration of database and its potential to participants from target institutions.

The GIS database was demonstrated to interested officers from TIs at the final workshop on 11 September. At this stage it is still a mapping rather than an analytical tool.

5.5.3. Training of Indian team in data management, use of GPS, establishment and maintenance of data management system, livelihood and stakeholder analysis.

Training in PRA techniques and approaches was given to the whole local research team by Adrienne Martin and MYRADA, a Bangalore based NGO which specialises in community development. This training workshop, entitled 'Participatory Approaches to Understanding Sustainable Livelihoods' was conducted from 5 to 9 March 2001 at one of MYRADA's field centres in south Karnataka. The objective was to get the local research away from Hubli-Dharwad for the period of the course. The course included theoretical approaches and practical fieldwork studying livelihoods of households from a range of backgrounds, and stakeholder analysis.

The local team were trained in use of MS Office: Word, Excel, Access, Power Point and the Internet during December 2000 to January 2001, and training time amounted to 60 hours per participant. Local commercial computer training schools were used. Paul Smith supplemented this with further sessions on use of Excel for analysis and constructing data entry forms in Access.

Andrew Packwood trained three members of the research team in use of the GPS receiver, transferring data into a GIS and plotting them as maps. The same members of the team were also trained in digitising maps and manipulating them using a GIS package. IDRISI was the initial GIS package used, due to its analytical capabilities. Later this was supplemented with Map Info, which is an easier to use mapping application.

6. Contribution of outputs

6.1 Contribution to programme goal and purpose.

NRSP's goal in the system logframe at the time the call for this project was issued was: '*Livelihoods of poor people improved though sustainably enhanced production and productivity of RNR systems'*.

This project is unlikely to have a direct effect upon livelihoods of poor people as that was not the purpose of the project. However, the project could certainly be said to have contributed to achieving the NRSP goal in that it has contributed to knowledge about NR and livelihoods of poor people dependent upon NR. This knowledge is a pre-requisite for development of appropriate interventions which are targeted at the right people.

NRSP's purpose in the system logframe at the time the call for this project was issued was: '*Benefits for poor people in targeted countries generated by application of new knowledge to natural resources management in peri-urban production systems'*.

This purpose looks forward to a stage when the new knowledge generated by this and related projects can be applied to NRM to benefit poor people. This project has contributed to this purpose in several ways.

1. Poor people in the peri-urban interface have been identified and their livelihoods characterised, and how these have changed as a result of change driven by urbanisation. This is a considerable advance on what was known previously, which was basically very little. The benefit of this knowledge is that the research team now knows who the poor are, and how to engage with them in dialogue. This is a pre-requisite for the next stage of participatory development pilot NRM projects, where, if the poor are not correctly identified they may not end up being the primary beneficiaries of the project. This stage has now commenced; indeed, it has almost finished, and the poor have been driving the agenda from almost the inception (as assessment of this will the subject of the R7959 FTR).
2. A considerable amount of new knowledge has been generated about natural resources and how they are managed, in many cases by the poor. This, too, is a significant advance on what was known previously, although more was known about NR before the project started than about the poor and their livelihood strategies. This project has pointed to several NRM issues which affect the poor:

    - The central role of dairying in livelihoods of the landless and farmers with little land, particularly in villages close to the city, and in particular their requirements for fodder;
    - Degradation of water resources in villages due to falling water tables and polluted drinking water supplies;
    - The importance of sewage irrigated vegetable and fruit tree production in several villages and its role in livelihoods of poor farmers;
    - The importance of cash crops in the livelihoods of all farmers;
    - The adaptability of farmers to changed circumstances in terms of variability of farming systems and mechanisms for marketing their produce, but also the lower diversity of farming systems of the poor and thus their greater vulnerability.

    This new knowledge is being applied already in the development, and now implementation, of pilot NRM projects.

3. The project has generated an understanding about what is different about livelihoods and NRM in the peri-urban interface. It is important to understand this distinction, otherwise conventional and well known rural development and research approaches may as well be applied. For example:

   - Distance from the urban centre strongly influences marketing of dairy products and thus the likely success or otherwise of any dairy interventions;
   - Likewise, distance also influences vegetable production because of the availability of assured irrigation from sewage nallas and cost of marketing of bulky, fresh produce;
   - Poorer people, and particularly landless (a finding from R7959) closer to the city are changing livelihood strategies to incorporate earning from the city wherever possible, but the poorest are having most difficulty in taking advantage of this (having to care for dependants, illiteracy – another finding from R7959);
   - Farmers who hire agricultural labour are changing farming systems due to competition for labour from the urban areas;
   - Mining for clay and building stone is providing alternative employment within villages for labourers in the summer, when agricultural employment is limited, but the degree to which this affects the village internal economy or cohesiveness of the social structure was not determined;
   - As a consequence of the foregoing three effects, pilot NRM projects which depend on community action may be more difficult to execute in a peri-urban context than in a more rural one (not a direct finding form this project, but this potential effect was identified and will be tested in the action plan implementation projects);
   - There is a tendency for land prices to be higher closer to the cities, particularly near Hubli, which may affect the use to which land is put after sale.

6.2. Attainment of project OVIs at purpose level

To what extent where the objectively verifiable indicators at the project purpose level attained?

6.2.1 Knowledge base adequate for formulation of plans of action for at least two aspects of NR management.

There is little doubt that this OVI was attained. Knowledge generated about dairying activities and vegetable production and their marketing and roles in livelihoods of the poor are two examples. However, subsequent development of action plans with village stakeholders (in project R7959) has revealed areas of NRM not covered by this project which would have been useful; the role of forests in livelihoods and watershed management in particular. Knowledge of these aspects is having to be gathered as projects R7959 and R8084 proceed.

This points to what might have been a better approach in this project. Had village stakeholders been able to participate in the identification of NRM issues of importance to them at the outset, then this project would to an extent have been better focused. This approach would have highlighted many relevant NRM issues; however, it would probably not have led to a better understanding of NRM in the peri-urban context unless a researcher designed sampling regime had been implemented due to the lack of awareness of peri-urban issues by village and government stakeholders. Another shortcoming of purely participatory approaches in project development is that actions proposed are limited by what village stakeholders know.

For example, Annex F highlights the lack of knowledge amongst farmers and extension agents of IPM approaches to pest control. Therefore a project which draws upon a combination of indigenous knowledge of NRM issues and expert technical knowledge would yield a more complete and relevant knowledge base.

6.2.2. Improved awareness of peri-urban natural resources management issues affecting the poor by key stakeholders.

There is little doubt that this project has attained an improved awareness of peri-urban NRM issues, and in many cases how these affect the poor. The question is: among whom has the awareness improved? The University of Agricultural Sciences, Dharwad (UAS) is a key stakeholder, and as many of the research team are employed by UAS, then awareness has increased in that organisation to that extent. UAS is involved in formulating extension recommendations arising from its research activities (it manages a chain of agricultural research station throughout north Karnataka, in addition to its teaching functions) with the relevant government line departments (Depts. of Agriculture, Horticulture, Livestock Husbandry, Livestock Health, Watershed Development). In the course of time, as projects continue, influence will be achieved in these research-extension committees, but not at this early stage.

6.2.3. Engagement of at least two target institutions in pro-poor dialogue with key stakeholders.

This cannot really be said to have been attained in this project. With the benefit of hindsight, it is realised that the data heavy nature of this project was not attractive to non-research organisations. However, in the course of execution of subsequent projects, TIs are being engaged in dialogue directly with the poor in project villages.

7. Publications and other communications material

7.1. Books and book chapters

Discussion are being held with Earthscan about publishing a book arising from the DPU International Conference, 'Peri-Urban Encounters: Managing the Environment of the Peri-Urban Interface', held in London, 9 – 10 November 2001. This project submitted one paper to that conference (see section 7.4. below), and Robert Brook is one of the editors of the proposed book.

7.2. Journal articles

None written so far, but this report contains material for at least six refereed journal articles, and researchers are well aware of the need to produce these over the course of the next year.

7.3. Institutional report series

Joshi, S. G. (2001) *Village water quality survey:* Karnataka Intergrated Rural Water Supply and Sanitation Project. Department of Rural Development and Panchyat Raj, Government of Karnataka.

7.4. Symposium and conference papers and posters.

C. S. Hunshal, K.J. Hillyer, A.T. Patil, P.Bhat & R. M. Brook (2001). *Livelihood Strategies In Response To Effects Of Urbanisation Around Hubli-Dharwad.* Paper presented at: Rural – urban encounter: Managing the environment of the peri-urban interface. DPU International Conference, University College London, November 2001.

Bradford, A. M., Brook R. M. and Hunshal, C. S. (2001) *Sewage irrigated farming systems, Peri-Urban Interface, Hubli-Dharwad, India.* Poster presented at: Rural – urban encounter: Managing the environment of the peri-urban interface. DPU International Conference, University College London, November 2001.

7.5. Newsletter articles

Bradford, A. M., Brook R. M. and Hunshal, C. S. (2002) *Risk Reduction in Sewage Irrigated Farming Systems in Hubli-Dharwad, India.* Article submitted to Urban Agriculture Magazine, Resource Centre for Urban Agriculture, ETC Netherlands.

7.6. Academic theses

Bradford, A.M. (2001) *Scope for Integrated Pest Management (IPM) in Sewage Irrigated Crop Production Systems in the Peri-Urban Interface of Hubli-Dharwad, India.* Unpublished MSc Thesis. University of Wales, Bangor.

7.7. Extension leaflets

None

7.8. Manuals and guidelines

None

7.9. Media presentations

Agfax January 2002, interview given by Robert Brook to Wren Media, for distribution to radio stations in developing countries.

7.10 Reports and data records

Datasets from surveys held on project computer at UAS. Datasets include:

Livestock (Access 2000)

Village level cropping systems (Access 2000)

Transect cropping systems (Access 2000)

Land transactions (Excel 2000)

Various maps of Hubli-Dharwad region (Map Info GIS format)

8. References

Ashley, C. and Maxwell, S. (2001) Rethinking rural development. *Development Policy Review* **19**: 395 – 425.

Bhalla, G. S., Hazell, P. and Kerr, J. (1999) *Prospects for India's cereal supply and demand to 2020.* Food, Agriculture and the Environment Discussion Paper 29. International Food Policy Research Institute, Washington.

Bhat, S. K. and Hegde, M. R. (1997) *Electrical resistivity behaviour of shale and schistose greywacke in northern part of Dharwad Schist Belt- a case study.* Dept. of Mines and Geology, Bangalore, Groundwater study No. 336.

Bureau of Indian Standards (1991). IS 10500. Government of India.

Delgado, C., Rosegrant, M., Steinfeld, H., Ehui, S. and Courbois, C. (1999) *Livestock to 2020. The next food revolution.* Food, Agriculture and the Environment Discussion Paper 28. International Food Policy Research Institute, Washington; UN Food & Agriculture Organisation, Rome; International Livestock Research Institute, Nairobi.

Devendra., C and Sevilla, C. C. (2002) Availability and use of feed resources in crop – animal systems in Aaia. *Agricultural Systems* **71**: 59 - 73.

Devendra., C and Thomas, D. (2002) Crop – animal systems in Asia: importance of livestock and characterisation of agro-ecological zones. *Agricultural Systems* **71**: 5 – 15.

Hegde, S.N. (1991) *Groundwater studies of Hubli Dharwad Municipal Corporation area. Karnataka, India.* PhD Thesis, Karnataka University, Dharwad.

Hunshal, C.S. Salakinkop, S.R. and Brook, R.M. (1997) Sewage irrigated vegetable production systems around Hubli-Dharwad, Karnataka, India. *Kasetsart Journal (Natural Sciences).* **32** (5): 1-8.

Joshi, S. G. (2001) *Village water quality survey:* Karnataka Intergrated Rural Water Supply and Sanitation Project. Department of Rural Development and Panchyat Raj, Government of Karnataka.

Nunan, F (1999) *Improved Utilisation of Urban Waste by Near-Urban Farmers in the Hubli-Dharwad City-Region.* Final Technical Report, Project R7099.

Nunan (2001) *Further knowledge of livelihoods affected by urban transition, Kumasi, Ghana.* Final Technical Report, Project R7854.

Rakodi, C. 1999. *Poverty and wellbeing in the peri-urban interface of developing countries.* DFID NRSP report, project PD70.

Satish Chandran, T.R. (1993), *Stagnation of agricultural productivity in Karnataka during the 1980s*, Report of the expert committee, Government of Karnataka.

Subhash Chandra (1994) *Occurrence of groundwater and aquifer characteristics of hard rocks in Karnataka.* In B.M. Ravundia and N. Ranganathan (Eds.), GeoKarnataka, Mysore, Geological Dept. centenary volume, Dept. of Mines and Geology, Bangalore, pp. 337-359.

Thomas, D., Zerbini, E., Parthasarathy Rao P. and Vaidyanathan, A. (2002) Increasing animal productivity on small mixed farms in South Asia: a systems perspective. *Agricultural Systems* **71**: 41 – 57.

Universities of Birmingham, Nottingham and Wales at Bangor, UK (1998) R6825; *Baseline study and introductory workshop for Hubli-Dharwad city-region, Karnataka, India.* Final Technical Report, NRSP.

9. Project logical framework

Narrative summary	Objectively verifiable indicators	Means of verification	Important assumptions
Goal			
1. Natural resources management strategies for peri-urban areas which benefit the poor developed and promoted.	By mid-2001 in Hubli-Dharwad city-region, key stakeholders (including at least two target institutions) regularly participating in the formulation of plans of action for at least two aspects of natural resources management for peri-urban areas which will benefit the poor.	Reviews by programme Manager. Reports of research team and collaborating/target institutes. Appropriate dissemination products Local, national and international statistical data. Data collected and collated by programme manager	Target beneficiaries adopt and use strategies and practices. Enabling environment exists. Budgets and programmes of target institutions are sufficient and well managed
Purpose			
1.3 New knowledge base created to fill any critical gaps in existing knowledge bases for use in developing pro-poor plans of action in Hubli-Dharwad and its region.	By project end: Knowledge base adequate for formulation of plans of action for at least two aspects of NR management. Improved awareness of peri-urban natural resources management issues affecting the poor by key stakeholders. Engagement of at least two target institutions in pro-poor dialogue with key stakeholders.	NRSP Annual Report . Mid-term review. External reviews of papers, reports. Reports of target institutions Plans of experimental and extension programmes of Karnataka Depts. of Agriculture, Livestock and Horticulture	Policy environment remains conducive to pro-poor approaches. Local governance of target institutions operates in such a way as to facilitate consideration and promotion of project outputs.

Outputs			
1. Better understanding of changes in the PUI driven by urban development: Specifically, changes in: 1.1. Cropping and livestock systems; 1.2. Produce and land marketing systems and their operation; 1.3. Underground water resources, and access to them by the poor. 2. Knowledge of who the poor and very poor, and key stakeholders in the PUI are, along with the characteristics of their livelihood strategies and factors influencing them. 3. Target institutions recognise how PU change impinges upon livelihood strategies of the poor. 4. Local research team more strongly articulate how livelihoods are affected by urban development and are able to maintain digital	1. By end of project, along transects from urban to peri-urban, characterisation of: 1.1. Cropping and livestock systems; 1.2. Produce and land marketing systems; 1.3. Underground water supplies. 2. By end of project, along transects from urban to peri-urban: 2.1. Poor and very poor identified; 2.2. Key stakeholders affecting the poor and very poor identified; 2.3. Main livelihood features of the poor and very poor described; 2.4. Main ways by which key stakeholders affect the poor and very poor described; 2.5. Principal ways by which change in the PUI affects all of the above defined. 3.1. During life of project, target institutions actively participate in project research activities. 3.2. By end of project, at least two target institutions informed about the projects knowledge base and its potential. 3.3. By end of project, at least two target institutions contribute to a project publication on a critical knowledge gap in the PUI. 4. By end of project: (a) team members communicate project's findings to stakeholder workshops and media outlets; and (b) local research team	1. Project quarterly reports and final technical report, workshop proceedings, project web site, academic publications. 2. Project quarterly reports and final technical report, workshop proceedings, project web site, academic publications. 3. Project quarterly reports and final technical report, workshop proceedings, project web site, academic and other publications. 4. Project quarterly reports and final technical report, workshop proceedings, radio	Engagement of target institutions is not jeopardised by major planning changes that affect urban area and the associated PUI. Data collected are adequate to fill gaps in knowledge. Target institutions other than those formally collaborating are prepared to engage in discussion and participate in identification of potential pro-poor plans of action.

database.	responsible for management and updating of the data the project generates.	broadcasts, accessible database of knowledge collected during project.	

Activities	**Budget and milestones**		
1. Surveys conducted along transects from urban to peri-urban to characterise: 1.1. Farm level: cropping and livestock systems and soil quality; 1.2. Produce and land market surveys systems and their operation; 1.3. Underground water resources and access to them. 2. Livelihood strategy, stakeholder and poverty analysis surveys and access to water resources surveys conducted, using participatory approaches. 3.1. Regular meetings and joint surveys during project, and final stakeholder workshop held to increase awareness of peri-urban issues of NR management, and their poverty implications. 3.2. Demonstration of database and its potential to participants from target institutions. 4. Training of Indian team in data management, use of GPS, establishment and maintenance of data management system, livelihood and stakeholder analysis.	Budget: UK staff: 28,779 Overseas personnel 21,064 Overheads 23,046 Capital equipment 6,350 Overseas T & S 19,182 Training and publications 1,475 Miscellaneous 3,300 TOTAL **103,196** Milestones: December 2000 Indian staff data collection and management training December 2000 Start of cropping, livestock, soil and market surveys. February 2001 Stakeholder, poverty and livelihood analysis training February 2001 Stakeholder, poverty, livelihood analysis and access to water resources surveys start. Hydrological study conducted May - June 2001 Data collection completed August 2001 Final stakeholder workshop, demonstration of project database. September 2001 FTR and joint publications with target institutions submitted. October 2001	No hindrances from civil or natural disturbance. Suitable Indian staff identified for recruitment and training. Willing participation of peri-urban stakeholders. Equipment operates as required. Surveys proceed according to plans. Where necessary, archived information able to be procured. Easy procurement of necessary base maps or satellite imagery.
			Pre-conditions:

10. Keywords

Natural resource management, cropping systems, livestock, livelihoods, poverty, land transactions, peri-urban interface, Hubli-Dharwad, India

11. Annexes

A. Agricultural Systems.

B. A study of the livelihood strategies of the poor and very poor in peri-urban areas of Hubli-Dharwad, and the impact of urbanisation upon them.

C. Economic and market analysis of agricultural systems in the peri-urban interface: Hubli-Dharwad.

D. Land transactions study.

E. Water resources around Hubli and Dharwad.

F. Sewage irrigated farming systems.