NATURAL RESOURCES SYSTEMS PROGRAMME

***FINAL TECHNICAL REPORT*[1]**

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Annex A

AGRICULTURAL SYSTEMS

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1. Background

Despite the influence of Hubli-Dharwad, land use beyond the boundaries of the Municipal Corporation is still predominantly agricultural. The Baseline Study (R6825) described land use systems at the taluk (block, or sub-district) level but not at a finer resolution. Agricultural statistics are collected at the taluk level (Universities of Birmingham *et al*., 1998: 39 – 40).

Consequently, that study was not able to determine whether there were any changes in agricultural systems that could be attributed to processes of urbanisation. Temporal trends were examined in four villages, and although significant shifts in cropping systems were reported, it was not possible to dissociate them from changes which could have been occurring all over Karnataka State (Universities of Birmingham *et al*., 1998: graphs 4.6 – 4.9). There was a spatial element in village sampling in that 25 villages across five taluka were examined, but conclusions could not be drawn about spatial effects from the data collected (which were essentially checklists of which cropping systems were present in each of the 25 villages sampled; Universities of Birmingham *et al*. (1998: table 4.2)), apart from the effects of soil type. The livestock component was limited to a study of secondary data and so was similarly unable to identify any spatial effects attributable to urbanisation.

The Knowledge Consolidation Study (R7549) concluded that 'Any strategy options explored by new projects will have to be based upon knowledge other than that generated by [previous] NRSP funded project[s].' and recommended that 'further information collecting will probably be necessary in village locations' (Brook, 2000). Accordingly, one of the output for the current projects was, 'Better understanding of changes in the PUI driven by urban development: specifically, changes in cropping and livestock systems' (see project logical framework). This annex describes the research conducted to achieve that output and the results arising from it.

2. Methodology

One of the hypotheses formulated for the study described here was that agricultural systems would vary spatially in relation to the city. A second hypothesis was that temporal changes would vary in their nature depending on proximity to the city.

The sampling design used to prove or disprove the hypotheses set employed four linear transects radiating from the twin cities. These ran for approximately 10 km from villages just within or close to the HDMC boundary to a village at the distal end of the line. These transects ran north and west from Dharwad and south and east from Hubli. The intention was to sample as wide a range of soil types and farming systems as possible to build as comprehensive a picture of farming systems as possible concomitant with the limited timeframe and funds available to the project.

The transect approach can be criticised for being non-random. However, it was realised that within the resources of the project that only seven or eight villages could be sampled in a manner that would answer the research questions set, and a small, random sample could easily miss some of the variability that the research team knew to be present. The transect method of sampling had the merit of being relatively unbiased.

The agricultural systems survey consisted of three components:

1. Cropping systems in villages at either end of each of the four transects (eight villages) to provide a comprehensive picture of cropping patterns and other use of land;
2. Cropping systems and soil sampling along the transects connecting the villages at either end to detect trends with distance;
3. Livestock systems in the eight study villages plus two extra villages.

2.1. Village crop survey

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.

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. 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, one for each survey number.

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. .

2.2. 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.

2.3. 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 (15km south west of Hubli, but the last 7km is a rough, unsurfaced road) as it was going to be included in the subsequent 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.

2.4. 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.

The use of such a formal systems of data entry was justified because there was no intention that the surveys be participatory 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.

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 here.

3. Results

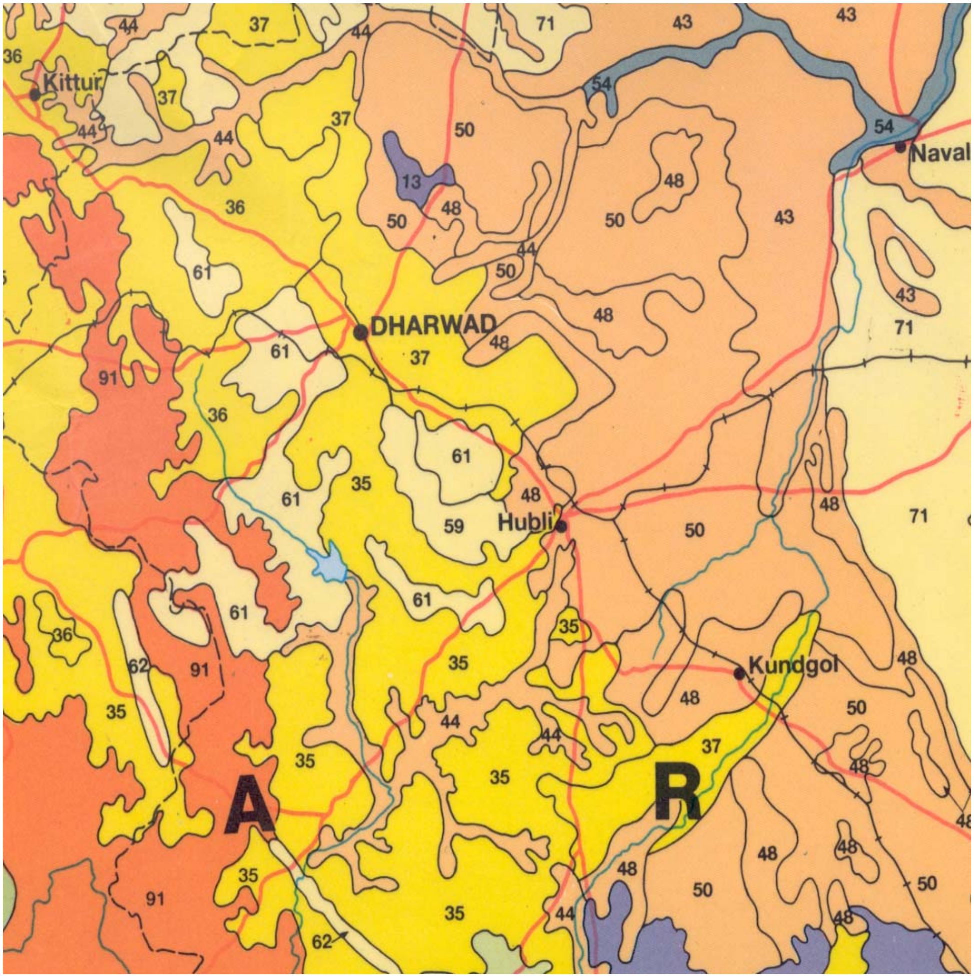
3.1. Transect surveys

Cropping systems are determined by two main physical factors; climate and soils. Rainfall data are only available at the taluk level, and as the project activities were conducted only in two taluka, Dharwad and Hubli, the resolution is too coarse to explain differences along transects, and the long term mean rainfall is 838mm and 693mm, respectively (NABARD, 2000). Data collected in the Baseline Study project R6825 show that the long term mean annual rainfall for the Agricultural Research Station at Mugad (near Mandihal) is 980mm and for UAS Dharwad (lying between Kelageri and Dasanakoppa) is 760mm. In general the rainfall declines sharply from west to east and less markedly from north to south. The major crop affected by the rainfall regime is rainfed rice (paddy), which dominates the 'kharif' (south west monsoon, 70% of annual rainfall received) season cropping on the western fringes of the study area. Further east and south rice is only grown where there is assured irrigation, and gives way to sorghum as the main staple crop.

A soil map for the project area is presented in Figure 1. The major division in soil types lies on a approximately north - south line running between Hubli and Dharwad. To the east lies the westerly edge of the Deccan Plateau, characterised by its black cotton soils. These are deep to very deep, calcareous, cracking clay soils generally known as vertisols. Soil pH is typically 8. These are suitable for growing potato and chilli in the kharif season and sorghum and wheat in the 'rabi' (north west monsoon, 30% of annual rainfall) season, whilst the longer duration cotton is planted during the kharif and matures in the rabi season. Onion is the most commonly grown vegetable, and very little rice is grown on these soils.

To the west of this zone lie the 'red' soils, which can be loosely described as alfisols and inceptisols. These have are typically pH 5.5, and gravelly with low water holding capacity, The main staple is rice, the principal annual cash crop is groundnut and the main tree crop is mango. In wetter areas or where soil water holding capacity is higher, a rabi crop is often grown, commonly green gram (mung bean). However, these generalisations hide a wide range of crop species, which will be described later.

Results from the soils samples at 500m intervals are presented in Tables 1 to 4. Regressions were conducted using distance as the determinant and the soil factor as the response variable. The hypothesis being tested was that soil nutrient status would vary in relation to proximity to the city. This rather unambitious hypothesis was postulated in recognition of the possibility that soil nutrient content trends could vary in either direction for different reasons. It could be postulated that soil near the city has less compost and artificial fertilizer added to it in anticipation of the land being sold for building or for non-agricultural use such as brick making. This is likely to apply to the alfisol soils as these are used for brick making and expansion of the city occurs on the westerly side (Figure 1). On the other hand, if intensive vegetable production is taking place, then it might be expected that this activity would take place close to the city and that these fields would receive heavy doses of fertilizer. Black soils are not used for brick making nor are sold for extensive building development because the swelling and shrinking clays are unsuitable for both bricks and for foundations of large structures.



Unit	Description	Soil family	Area
61	Very shallow, welldrained, gravelly loam soils on rolling lands, strongly gravelly in the subsoil, with severe erosion; *associated with:* Moderately shallow, welldrained, clayey soils with low AWC, moderately eroded.	O Loamy-skeletal, mixed Lithic Ustorthents O Fine, mixed, Typic Ustropepts	84.35 (0.44)
35	Moderately deep, welldrained, clayey soils on rolling lands, with slight erosion; *associated with:* Very shallow, somewhat excessively drained, gravelly loam soils with very low AWC, severely eroded.	O Fine, mixed, Typic Ustropepts O Loamy-skeletal, mixed, Lithic Ustorthents	123.87 (0.65)
36	Moderately shallow, welldrained, clayey soils with low AWC on rolling lands, with moderate erosion; *associated with:* Moderately shallow, welldrained, clayey soils with low AWC.	O Fine, mixed, Typic Ustropepts O Fine, mixed, Typic Haplustalfs	35.91 (0.18)
37	Moderately deep, welldrained, clayey soils on gently sloping interfluves, with moderate erosion; *associated with:* Very shallow, somewhat excessively drained, loamy soils with low AWC.	O Fine, mixed, Typic Ustropepts O Loamy, mixed, Lithic Ustorthents	111.78 (0.59)
59	Shallow, somewhat excessively drained, gravelly loam soils with very low AWC on undulating interfluves, with severe erosion; *associated with:* Moderately shallow, welldrained, gravelly clay soils with very low AWC, moderately eroded.	O Loamy-skeletal, mixed Lithic Ustorthents O Clayey-skeletal, mixed, Typic Ustropepts	36.70 (0.20)
48	Very deep, moderately welldrained, calcareous, cracking clay soils on gently sloping interfluves and valleys, with slight erosion; *associated with:* Deep, welldrained, calcareous, clayey soils.	O Very-fine, montmorillonitic, Typic Chromusterts O Fine, montmorillonitic, Vertic Ustropepts	302.17 (1.59)
49	Deep, moderately welldrained, calcareous, cracking clay soils on gently sloping interfluves, with slight erosion; *associated with:* Moderately shallow, moderately well drained, calcareous, clayey soils.	O Very-fine, montmorillonitic, Typic Chromusterts O Fine, montmorillonitic, Ustollic Calciorthids	68.42 (0.36)
50	Deep, moderately welldrained, cracking clay soils on gently sloping interfluves, with severe erosion; *associated with:* Deep, moderately welldrained, calcareous, cracking clay soils.	O Very-fine, montmorillonitic, Typic Chromusterts O Very-fine, montmorillonitic, Typic Pellusterts	296.48 (1.55)

Table 1 Soil test analysis for Kelageri to Mandihal transect

Distance m	pH	Available N kg/ha	Available P kg/ha	Available K kg/ha
500	6.8	144	4.0	466
1000	5.8	140	6.1	444
1500	5.6	172	6.7	397
2000	5.7	222	3.0	421
2500	6.6	219	3.6	596
3000	6.6	109	9.5	352
3500	6.5	179	6.1	932
4000	6.2	271	8.6	439
4500	5.6	266	8.0	530
5000	5.9	242	8.1	409
5500	5.7	270	5.0	454
6000	5.9	368	5.6	793
6500	7.2	158	4.0	512
7000	6.4	254	3.2	507
Mean	6.18	215.3	5.82	518.0
Regression				
F ratio	0.148	6.18	0.018	0.729
Probability	0.707	0.029	0.896	0.41
R^2	0%	28.50%	0%	0%
Equation y =	-	142 + 0.019x	-	-

Table 2 Soil test analysis for Dasanakoppa to Pudakalakatti transect

Distance m	pH	Available N kg/ha	Available P kg/ha	Available K kg/ha
500	6.7	109	10.1	545
1000	6.8	110	9.0	600
1500	6.9	112	9.1	581
2000	6.9	102	11.2	716
2500	7.9	119	5.8	735
3000	7.8	112	10.1	730
3500	8.2	95	11.7	545
4000	8.2	113	8.2	536
4500	8.0	166	10.7	913
5000	8.3	123	9.2	541
5500	8.1	123	8.1	528
6000	8.2	106	13.6	769
6500	8.2	113	10.1	730
7000	8.0	116	9.6	800
7500	7.2	137	6.1	711
Mean	7.69	117.1	9.51	665.3
Regression				
F ratio	8.58	1.77	0.003	1.93
Probability	0.012	0.211	0.873	0.188
R^2	35.1%	4.90%	0%	6%
Equation y =	7.01 + 0.00017x	-	-	-

On the Kelageri to Mandihal transect (Table 1), only one trend revealed a significant regression, available N. A number of reasons could be advanced for this observation. Brick making is particularly prevalent in Kelageri (see Box 1, main report), so soil nutrient 'mining' could be taking place prior to selling or leasing land for clay extraction.

Also, as it lies within the HDMC boundary it is a designated building zone. Additionally, there could be an effect of change of cropping system along the transect. Figures 2, 4 and 4 reveal that in Kelageri and immediately to the west, mango and other orchards are major cropping systems, and these presumably would receive little if any fertilizer. Further west, in the 'kharif' season (monsoon) rice is the major crop and studies of farmer soil nutrient management during R7099 showed that this crop is well fertilized with manure based composts and urea.

Along the Dasanakoppa to Pudakalakatti transect, apart from pH there were no significant trends. The rise in pH can be explained by the predominance of low pH alfisols soils at the Dharwad end, changing to high pH, calcareous vertisols soils at the northern end (Figure 1). As Figure 3 shows, although the cropping systems were far from homogeneous, there was no clearly discernible trend along the transect.

The Gabbur to Inamveerapur transect is also in a soil transition zone (Figure 1), and to complicate matters further much of it lies along the Hire nalla, a natural watercourse flowing away from Hubli, from where sewage contaminated water is pumped to irrigate the fields (Appendix 3, Annex F), often several hundreds of metres. However, the quantity of water available for irrigation decreases along the nalla due to water being pumped out upstream so that by the time the nalla reaches Inamveerapur, in the dry season very little water remains. The significant decrease in available N and K as the transect moved away from Hubli could be explained by the quantities of sewage waste water available for irrigation. Figure 3 does not indicate any clear trend in cropping systems, although Bradford did report a shift from vegetable cropping to fruit tree based agroforestry systems with increased distance from Hubli (Section 4.3, Annex F).

Table 3 Soil test analysis for Gabbur to Inamveerapur transect

Distance m	pH	Available N kg/ha	Available P kg/ha	Available K kg/ha
500	7.6	224	11.5	864
1000	7.6	131	10.1	727
1500	7.6	125	9.3	539
2000	8.0	168	12.1	535
2500	7.8	169	10.6	790
3000	6.8	189	8.1	799
3500	7.9	131	15.6	520
4000	8.6	173	16.1	439
4500	7.9	138	15.0	515
5000	8.2	119	16.0	471
5500	8.4	147	14.6	668
6000	8.3	138	13.1	605
6500	8.3	131	10.1	600
7000	8.0	138	12.6	340
7500	7.9	119	13.0	387
Mean	7.93	149.3	12.5	586.6
Regression				
F ratio	4.49	5.07	2.17	8.33
Probability	0.054	0.042	0.165	0.013
R^2	20%	22.5%	7.7%	34.4%
Equation y =	-	177 - 0.007x	-	760 - 0.0044x

From Bidnal to Shiraguppi the soil type is consistently deep, cracking clays. The analysis shows two significant trends for available N and K (Table 4). These nutrient levels increased with distance from Hubli. There were no obvious trends in the cropping system, as the chilli – cotton system dominates. This is very profitable and high rates of fertilizer are applied to it (pit compost at 4.5 t/ha/y and di-ammonium phosphate at a mean rate of 197 kg/ha/y; Nunan, 1999: Table 2.1). However, Bidnal, like Kelageri, lies within the HDMC boundary and this may engender a reluctance to apply heavy doses of fertilizer in anticipation of land being built upon.

A caveat needs to be added to this discussion of trends in soil nutrient availability which is that the explanatory variable (distance) in fact explains relatively little of the variation observed in available nutrients (ranging from 17.6% to 35.1% for significant effects). Although statistically the trends did not occur by chance, a degree of caution should be used in interpreting the trends.

Table 4 Soil test analysis for Bidnal to Shiraguppi transect

Distance m	pH	Available N kg/ha	Available P kg/ha	Available K kg/ha
500	8.1	100	7.5	307
1000	8.6	99	5.0	433
1500	8.5	106	13.0	289
2000	8.5	107	7.0	371
2500	8.0	110	10.1	370
3000	8.3	92	4.7	261
3500	8.7	99	15.6	127
4000	8.1	106	13.3	582
4500	8.5	100	16.8	313
5000	8.2	119	15.6	541
5500	8.2	113	9.0	466
6000	8.5	102	12.2	450
6500	8.1	116	10.1	443
7000	8.0	113	3.2	399
7500	8.4	110	14.1	390
8000	8.3	116	16.7	564
8500	8.3	105	12.2	615
9000	8.8	112	7.8	420
9500	8.5	110	15.6	575
10000	8.5	105	11.6	564
10500	8.0	105	15.6	939
11000	8.8	116	14.0	210
Mean	8.36	107.3	11.4	437.7
Regression				
F ratio	0.41	5.49	3.40	6.12
Probability	0.531	0.03	0.080	0.022
R^2	0%	17.6%	10.3%	19.6%
Equation y =	-	102 - 0.001x	-	291 - 0.026x

The presence of soil and climate trends running in different directions means that variations in observed cropping systems may not be due to processes of urbanisation. However, when considered in conjunction with marketing activities (Annex C) and an understanding of livelihood strategies, patterns due to urbanisation can be detected.

Figure 2 presents data for the two transects radiating west and north from Dharwad. Along each 500m section there were a total of ten observations, one on either side of the line taken at 100m intervals. Consequently, proportion of land occupied by crops is accurate only to the nearest 10%, as a result of which the diagrams look quite coarse. For reasons controlled by the timing of the project, the season used for conducting the survey was not ideal; 'rabi', when only either perennial crops or those which could withstand maturing on residual soil moisture were present. Nevertheless, trends are discernible.

From Kelageri to Mandihal (see Figure 1, Annex B for locations of villages), two land uses dominated: mango and grass (post kharif summer fallow used for rough grazing). Mango rose to a peak 2km from Kelageri (occupying 100% of land for one 500m stretch) and rapidly declined to 20% or less of land by 5km. A range of cropping systems replaced it, dominated by grass (rough grazing) with some irrigated rice and other cereals. The soils and the rainfall regime to the west of Hubli-Dharwad are considered to be particularly suitable for cultivation of mango. The most widely grow variety, 'Alfonso' is valued as a dessert fruit and is exported. Besides fresh sales in the market or at roadside stalls, there is a mango canning factory in Hubli. Mango benefits from a favourable taxation regime and is a favourite form of 'annuity' for retired high ranking public servants who live in the city.

The transect from Dasanakoppa to Pudakalakatti lies along the transition between the two major soil types, and the cropping systems reflect this (Figure 2). There is not a clearly discernible trend with distance from Dharwad, or it may be that any trends are masked by variability arising from farmers responding to soil type. This zone is too dry for rainfed rice and as there is little irrigation, at the time of the survey no rice was being grown. Three types of crops dominate; cotton, cereals (mostly sorghum and wheat, with some millets) and pulses (mostly chickpea, otherwise known as bengal gram). Intercrops refer to various combinations of the foregoing. Fruits, which occur both close to Dharwad and at about the 7km mark, do not refer to mango but to banana and fruit trees such as sapota. Vegetables are also grown from 4.5km outwards.

From Hubli, the southerly transect was influenced by the course of the Hire nalla, heavily polluted with untreated sewage. For a more extensive discussion of cropping systems utilising sewage waste water see Appendix F. Unlike the Kelageri to Mandihal transect, there was no clearly discernible trend in crop type associated with distance, with perhaps the exception of a concentration of vegetables up to the 3 km point from the Hubli end of the transect. This area is also on the line of transition from black to red soils.

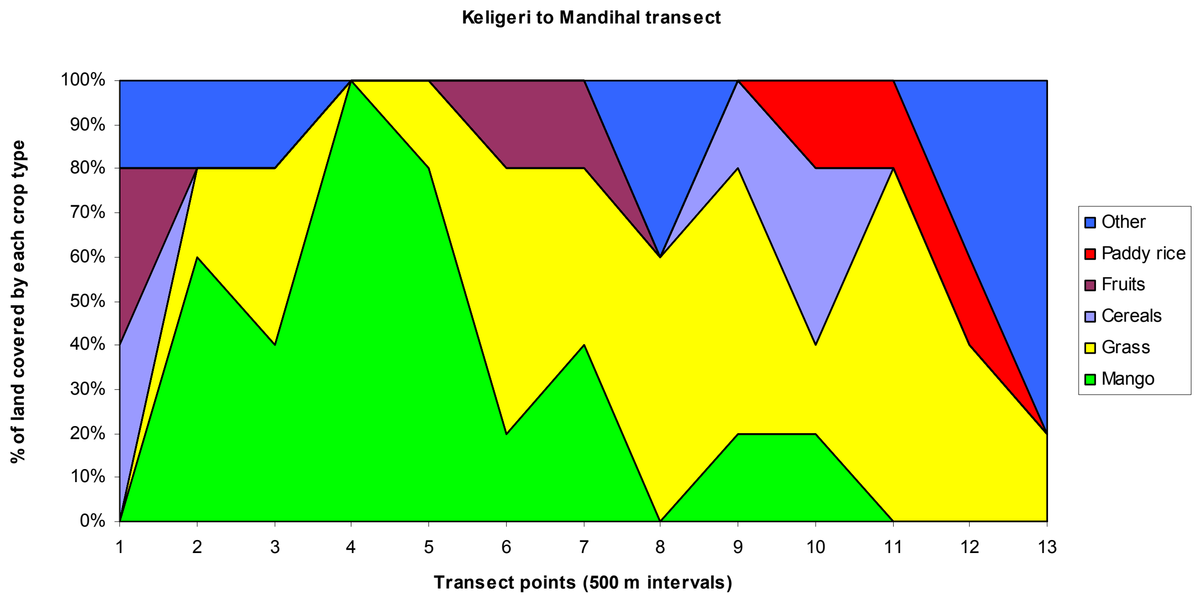
Cereals on this transect refer mainly to sorghum and maize. Sorghum is grown as a staple food and also as livestock fodder, which is also the main reason for growing forage maize. Fruit trees are present along most of the transect, the main species being sapota and guava (see Annex C). Intercrops include pulses such as pigeon pea (red gram) and mung bean (green gram) with either cotton or chilli. Oilseeds refers mostly to groundnut.

The Hubli east transect shows the least variation. The soils are consistently deep, black, cracking clays where the chilli - cotton intercropping system dominates. This will be discussed further when considering the cropping systems of Bidnal and Shiraguppi villages. The main cereals grown in the rabi season on these soils are wheat and sorghum. Intercrops refer mostly to the practice if intercropping wheat with safflower grown for oil.

In summary, the transect study revealed:

- Trends in pH, available N and available K (but not available P) along some transects which in some cases could be attributable to nutrient mining of soils prior to them being converted to non-agricultural use.
- The great variability in cropping systems around Hubli-Dharwad, to the point that it is impossible to generalise.
- Soil type and rainfall are major determinants of cropping systems.
- 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.

Figure 2 Cropping systems along linear transects, Dharwad



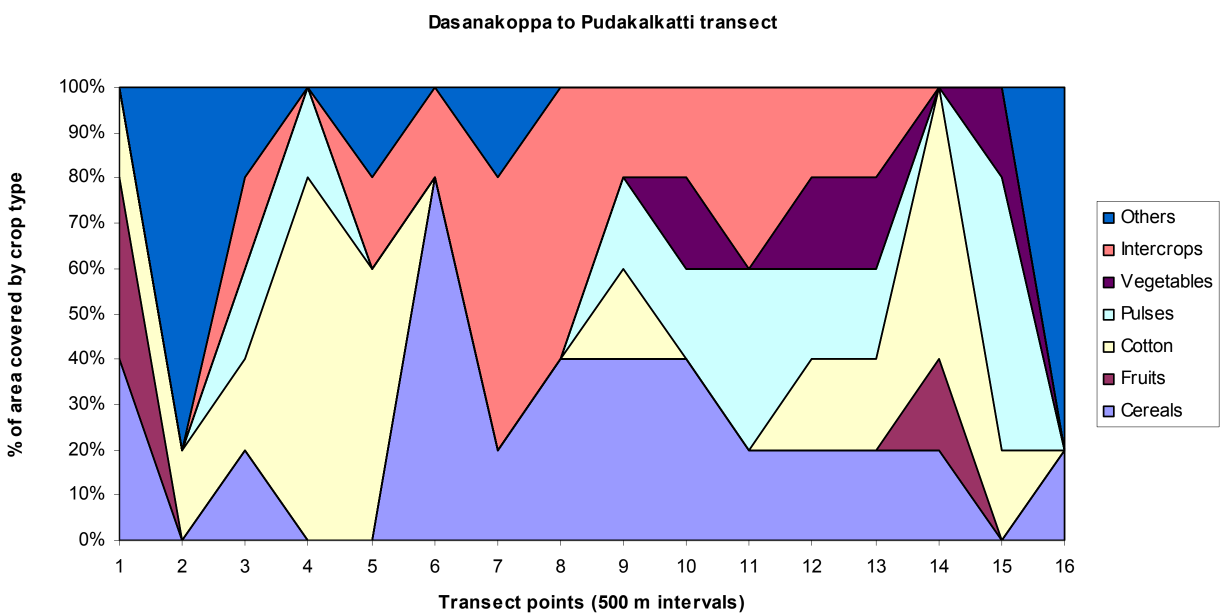
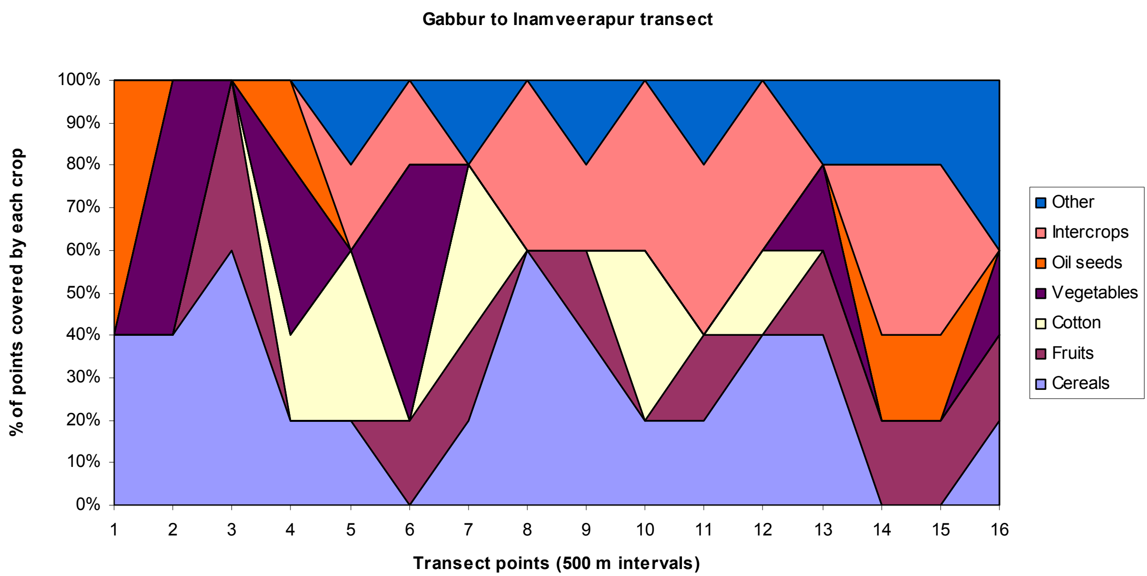
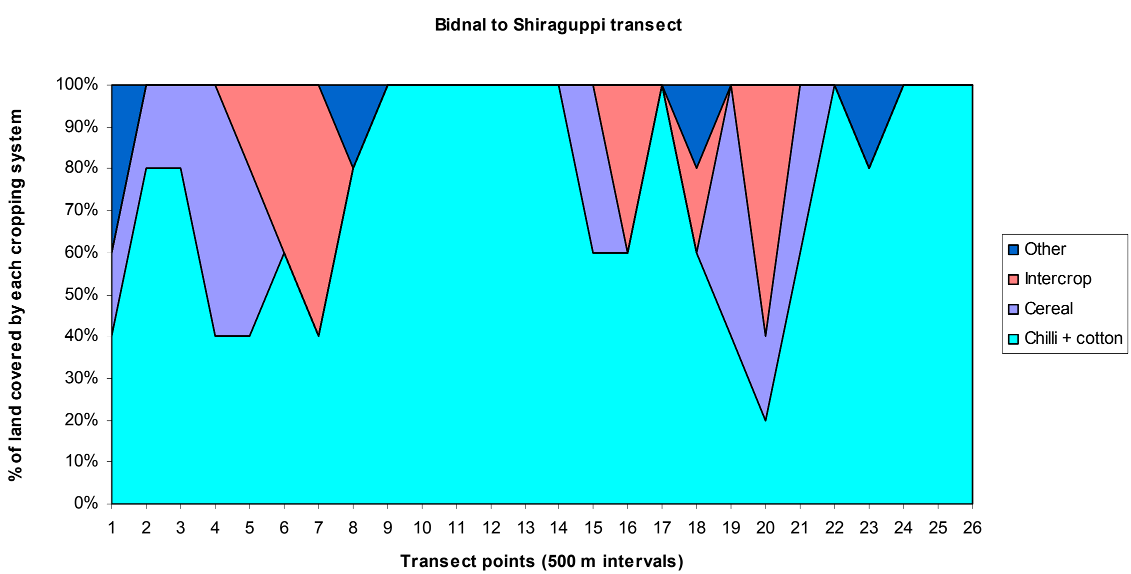


Figure 3 Cropping systems along linear transects, Hubli





3.2. Whole village cropping system surveys

Cropping systems for the eight case study villages are presented in Figures 4 to 11. It should be borne in mind that the sample was total i.e. data were gathered for all the fields in the village for both the kharif and rabi seasons in 2001. Consequently, within the village there was no sampling error. The total survey area for Kelageri is reported in official records as 2499 ha, of which in the kharif season, 78.8% is cultivated. The rest of the land is built upon or classed as 'non-cultivated waste land'.

In the case of Kelageri, the total list of crops and intercropping combinations listed is 51. These were so many that in the preparation of the pie chart (Figure 4), names of many minor crops were deleted as it was impossible to read their names on the diagram. The cropping systems were very diverse. An index of ecological variability, the Shannon - Weiner Index, was calculated (Kent and Coker, 1992). The methodology for this is presented in Appendix B7 in Annex B, as it was also used to estimate diversity of livelihood strategies. In the case of Kelageri, the Shannon - Weiner Index = 2.36 for the kharif season but only 0.76 for rabi crops. Diversity is much lower in the rabi season because much land is uncultivated and the consequent weedy, summer fallow is used for rough grazing. It should be noted that although perennial crops are include in the calculation of the diversity index for the kharif season, these are excluded from the calculation for the rabi season to obtain an index of newly sown annual crop diversity.

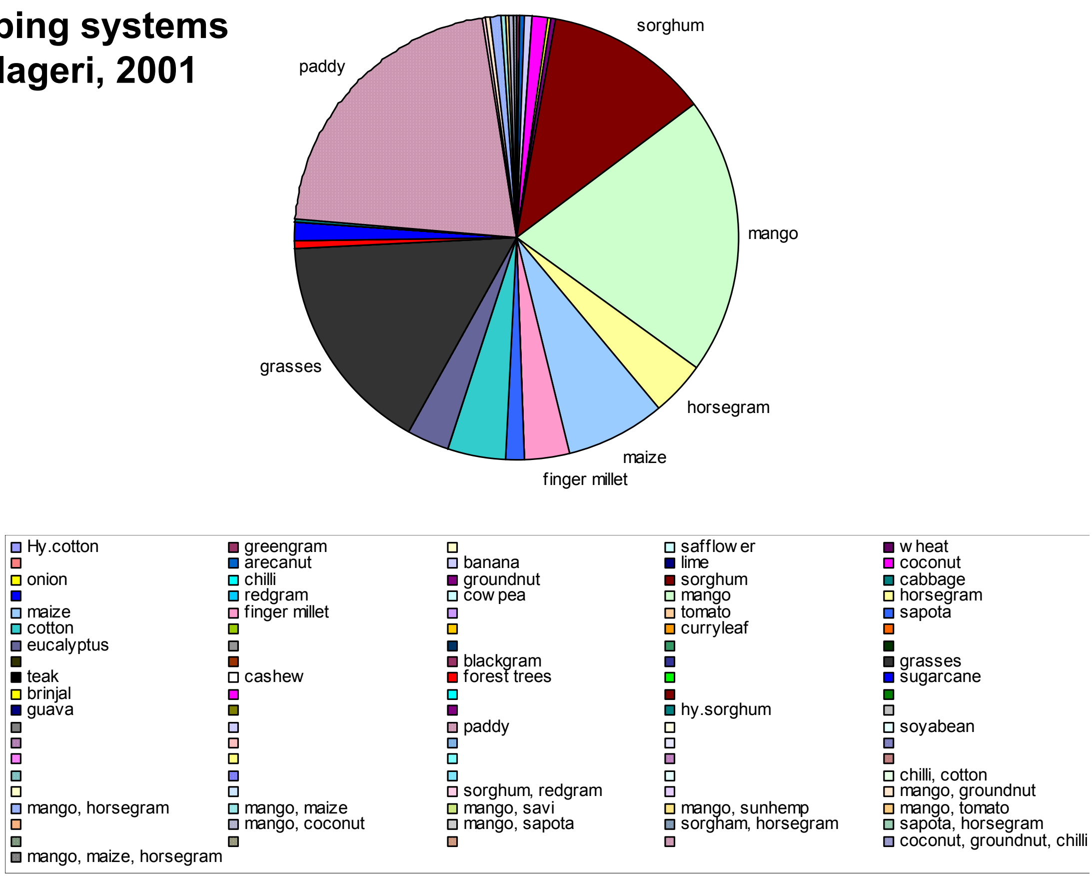
The diversity of crops in Kelageri contradicts the findings in the marketing survey where relatively little variation was found (Annex C, page C3). In the latter case this was almost certainly due to sampling error in selecting respondents.

In the kharif season the main cropping systems were mango, often with grass underneath (which was simply recorded as sole mango) or with other understorey crops such as maize and horsegram. Paddy, grasses and sorghum were other major cropping systems. The cause or use of the large areas of grass as not ascertained. Most would be used for grazing, but in general it is not usual to find large areas of grass in an village around Hubli-Dharwad in the kharif, as in most villages the land is intensively cropped. . Some of the grassland may be worked out brick pits, where the clay rich upper horizons, generally the top 1m or so, are stripped off. The subsoil is abandoned to grow weedy scrub. Another source of grassland is abandoned farms. The team first became aware of his phenomenon during the inception visit by the UK team in December 2000. The team visited Jogyellapur, west of Dharwad, 2km from the edge of the city. In that village there were significant areas of abandoned farms (pers. comm, Gram Panchayat chair) which were being grazed by cattle. The reason for abandonment was that the owners had found more remunerative work in Dharwad, and they had turned heir cattle loose to graze wherever they will. This had caused the end of rabi cropping in the village due to damage by cattle looking for green vegetation.

In the rabi season, for clarity of comparison in the pie chart (Figure 4), perennial crops such as mango are excluded. Thus, only annual crops specifically cultivated in the rabi are shown. The area cultivated was 11.5% of the total village land area, indicating the great degree of summer fallowing. This is due to the low water holding capacity of the soil. The main rabi crop is *Dolichos lablab*, known locally in English as 'field bean', but this term is so widely used around the world to mean different crops that it will not be used again in this report.

Figure 4
Cropping systems In Kelageri, 2001

Kelageri kharif cropping area



Kelageri rabi cropping system area

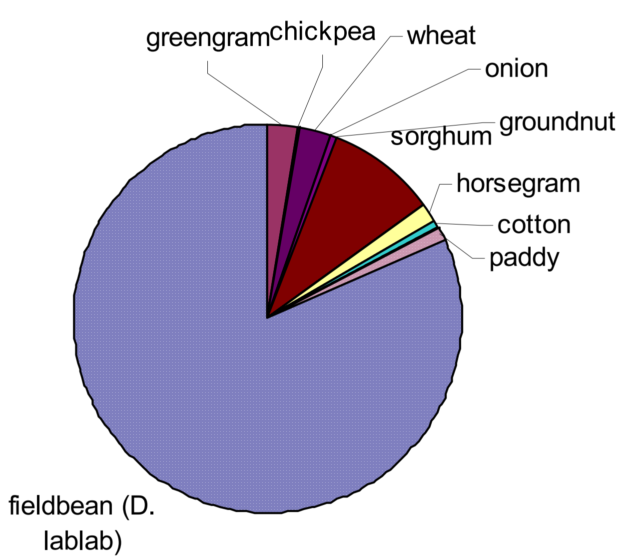
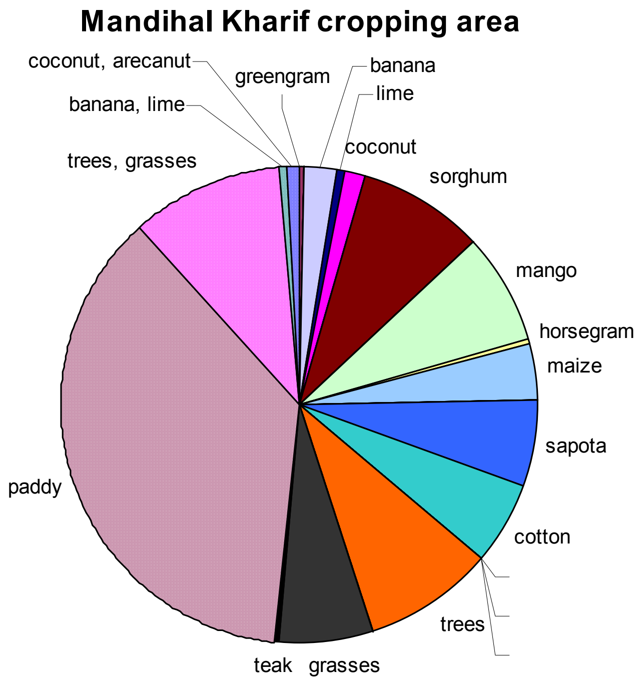


Figure 5 Cropping systems in Mandihal, 2001



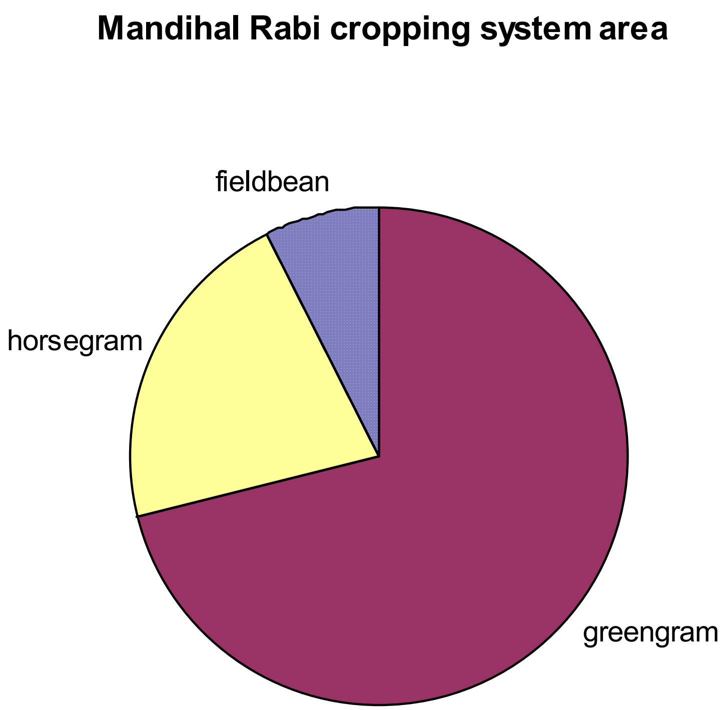
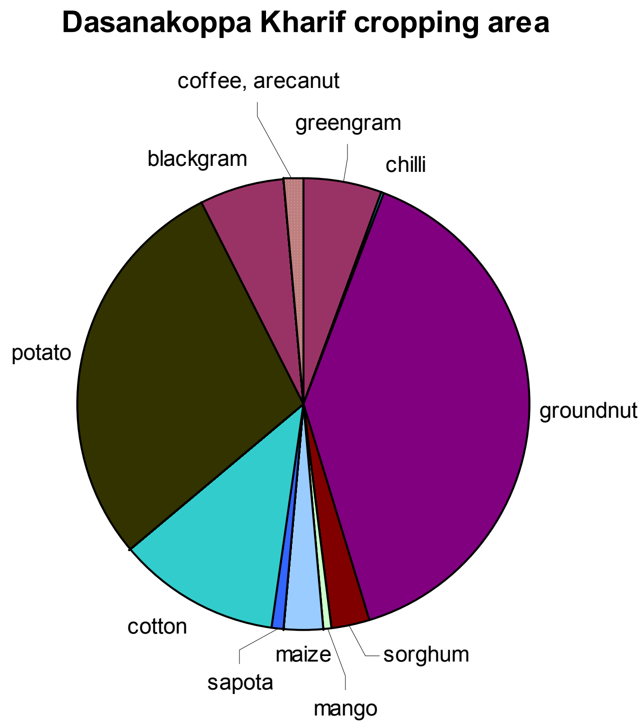


Figure 6 Cropping systems in Dasanakoppa, 2001



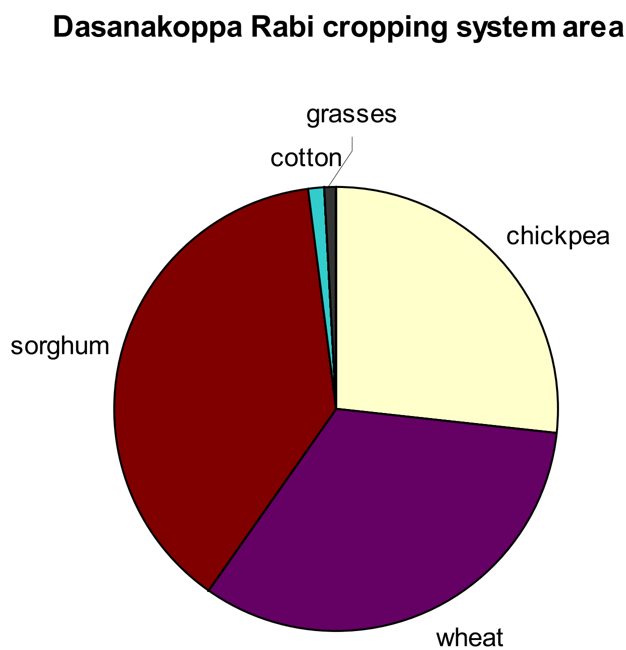
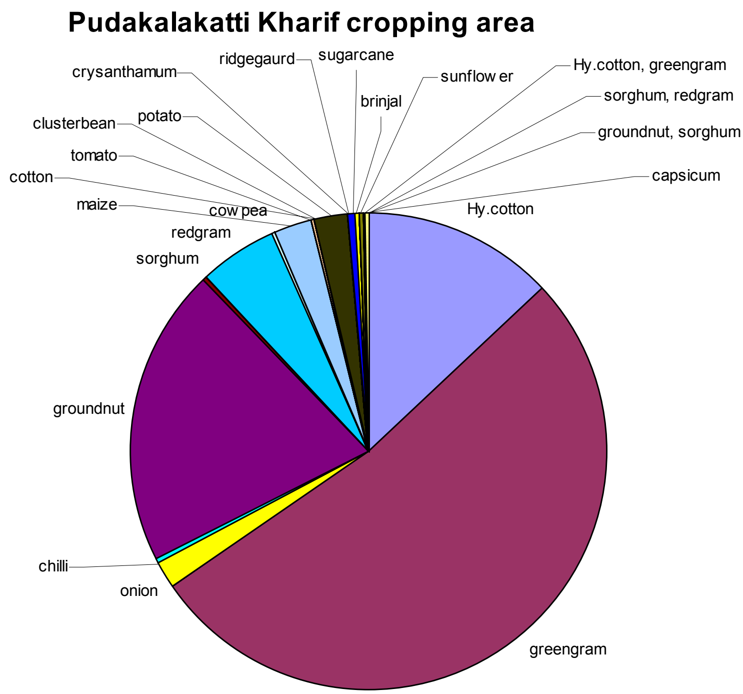


Figure 7 Cropping systems in Pudakalkatti, 2001



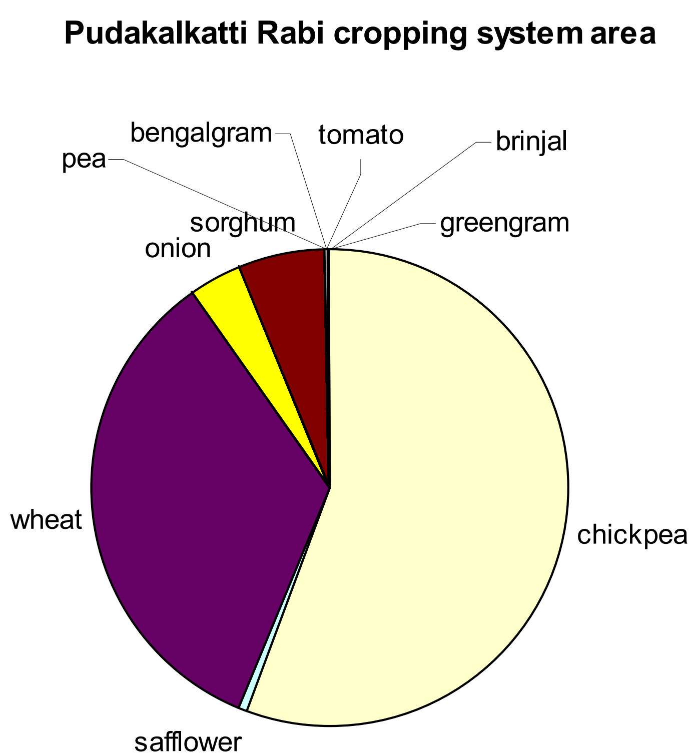
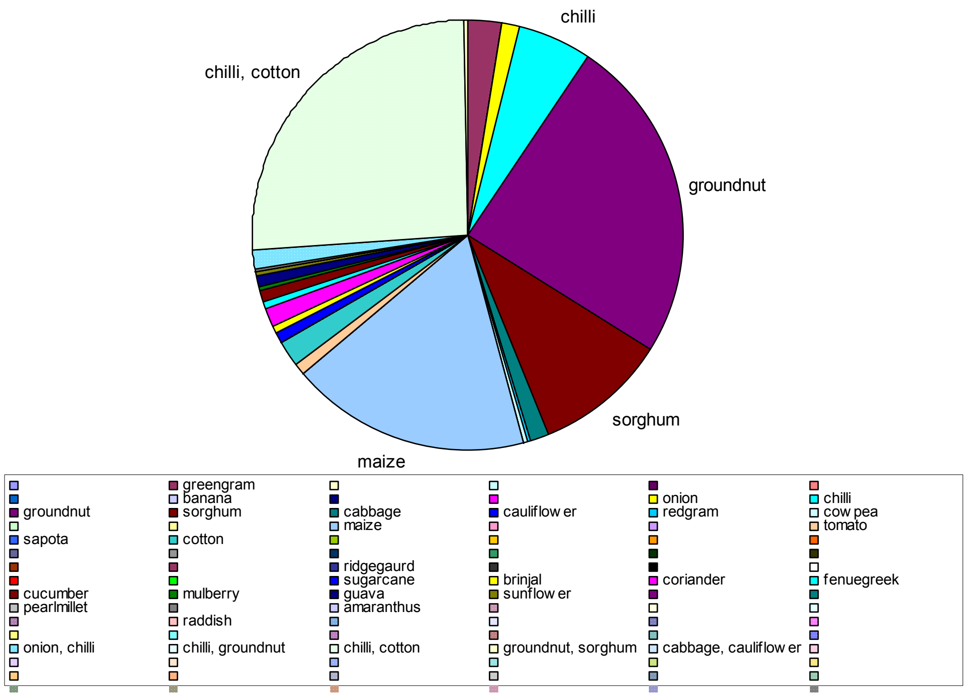
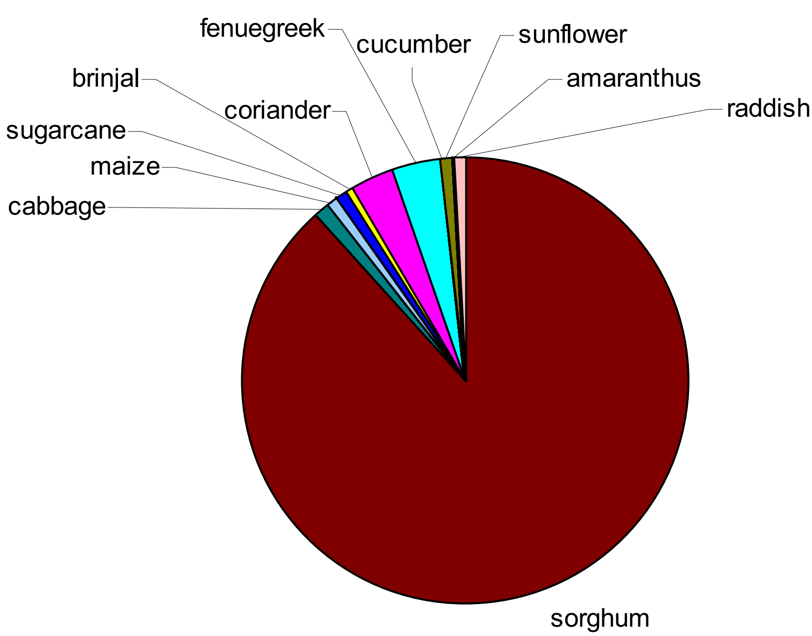


Figure 8 Cropping systems in Gabbur, 2001

Gabbur Kharif cropping area



Gabbur Rabi cropping systems area



In Mandihal, at the far end of the westerly transect, the total village land area is 481ha, of which 91.4% is cultivated in the kharif season. Soils are inceptisols and alfisols, similar to Kelageri, and the dominant kharif crop is paddy (rice). Other annual crops of much less importance are sorghum, cotton and maize (Figure 5). However, it is noticeable that perennials such as teak, banana, mango and general 'trees' are a major part of the land use system. Rainfall in Mandihal is similar to that in Mugad, supporting trees adapted to wetter climates. The Shannon – Weiner diversity index for kharif is 2.14, somewhat lower than for Kelageri.

In the rabi season, only 8.5% of the total village area is sown to annual crops due to the low water holding capacity of the soil. Grain legumes dominate what crops are grown. The diversity index = 0.77, which is similar to Kelageri, and excludes perennial species.

Dasanakoppa is at the Dharwad end of the northerly transect. The total village area is 159ha, of which 95.5% is cultivated in the kharif season. Its location is transitional between the two major soil types, but has predominantly vertic soils. This is reflected in the crops grown: potato and groundnut are co-dominant but soils are not deep enough for cotton to dominate, although it is present (Figure 6). There are very few trees; mango, sapota and arecanut make up a very small proportion of the area cultivated. Kharif crop diversity = 1.64, and is low. There are very few vegetables in this village (0.5% of land area) which may reflect frictional distance. Although it is close to the outskirts of Dharwad, it is approached along a poor road which discourages public transport (only one bus per day: Annex C Figure 5). It is only a small village, and it has many characteristics of more distant rural villages.

In the rabi season, 81.4% of the land is cultivated, indicating the high water holding capacity of the soil. The three co-dominant crops are wheat, sorghum and chickpea, which are all adapted to maturing on residual soil moisture (Figure 6). Cropping diversity is 1.18, rather higher than for Kelageri and Mandihal, reflecting the fact that most of the agricultural land is cultivated in the rabi season.

Pudakalkatti lies at the far end of the Dharwad north transect, and has a total land area of 687 ha, 78.8% of which are cropped in the kharif season. Soils are predominantly vertic soils, but transitional with alfisols. Green gram, or mung bean, occupies over half the cultivated area, and groundnut nearly one quarter (Figure 7). Why green gram should be so dominant was not ascertained, but it is noticeable that some villages tend to specialise in certain crops. The kharif diversity index is 1.50, the lowest of any of the villages along the Dharwad transects.

In the rabi season, only 11.5% of the land is cultivated, presumably reflecting low water holding capacity of the soils in this area. Chickpea and wheat are the dominant crops (bengal gram is a mistake in the reporting, as it is the same as chickpea). Cropping systems diversity index = 1.03. It is clear that in this village, pulses dominate in both cropping seasons.

Near Hubli, Gabbur is influenced by lying within the HDMC boundary and has access to sewage irrigation. Soils are transitional between vertic and alfisols. The village area is 1042ha, of which 92% is cropped in the kharif season. Although it is classifies as being urban, the character of the village is nevertheless rural. Main crops are groundnut, chilli and cotton intercrop, and maize. The cropping diversity index is 2.13. In the rabi season, 18.4% of the land area is cultivated, some with sewage irrigation. Although sorghum is the dominant crop by a wide margin, numerous irrigated horticultural crops are grown such as cabbage, brinjal (aubergine), fenugreek, cucumber, amaranthus, radish (Figure 8). Many buffaloes are kept in the village for dairy, and this may explain the extent of summer fallow. The buffalo can graze this are at a time when fodder is in short supply. This may also apply to Kelageri, where dairying is also important. Crop diversity index in the rabi season is 0.58.

At the southerly end of that transect, Inamveerapur has a wide diversity of crops (Shannon – Weiner index = 2.51) as can be seen in Figure 9. The village is a small one, with a total land area of 390ha, of which 90% is under cultivation in the kharif season, and 14.5% in the rabi season. Maize and sorghum are the main annual crops in the kharif season, and orchards (sapota, guava, mulberry, the latter for sericulture) occupy one quarter of the land, although numerous other crops are also grown. In the rabi season, the diversity index decreases to 1.64, but this is most diverse of all the rabi cropping systems in the eight villages studied. Wheat and sorghum are the dominant annual crops.

At the Hubli end of the easterly transect, Bidnal has a land area of 287ha, of which only 30% is cultivated in the kharif season. This low value reflects the area of land occupied by buildings and roads. Nevertheless, agriculture is still practised, with chilli – cotton intercropping and groundnut dominating the kharif season (Figure 10). The diversity index, at 1.61, is low for the kharif season, and declines to 0.45 in the rabi season, when the proportion of land cultivated decreases to 6.4%. The dominant crop is sorghum. This is the most urbanised of the eight villages studied, and is now virtually a suburb of Hubli. This can be contrasted with the rural nature of Gabbur, which is almost the neighbouring village.

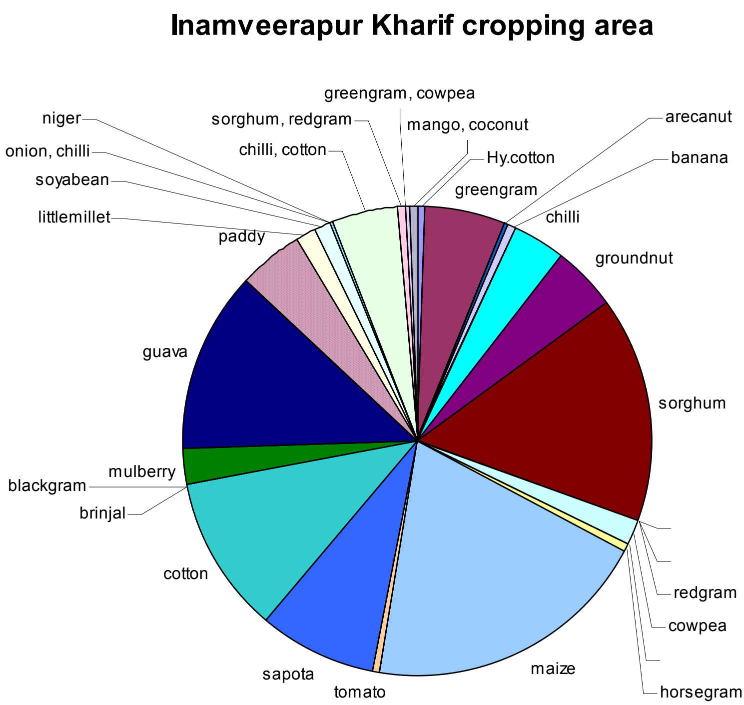
At the eastern end of the transect, Shiraguppi has a large land area, which is typical of villages on the cracking clay soils. Total land area is 2867ha, of which 96% is cropped in the kharif season, the highest proportion of all the eight study villages. The chilli – cotton – onion cropping system occupies two thirds of the cropped area, and this dominance is reflected in the lowest kharif diversity index of 1.30 (Figure 11).

In the kharif season, 14.7% of the land area is cropped. Wheat, either sole or intercropped with safflower, is the major crop (Figure 11), and chickpea is also important. The cropping diversity index = 1.42. That it is higher than in the kharif season may appear to be surprising, but calculation of the index takes into account not just number of different species, but also the evenness of the their distribution.

A hypothesis concerning diversity of cropping enterprises that could be set would be that household farm enterprises closer to the city are more diverse than those further away due to easier access to markets. Table 5 sets out the Shannon – Weiner diversity index for the kharif and rabi seasons for ease of comparison. For the kharif season, the mean diversity was greater, although not greatly. 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.

In summary, the study of cropping systems at the whole village level reveals a very diverse scenario. Cropping systems are sophisticated and diverse, being matched to soil type, climate, market and probably also influenced by tradition. Thus, it is not possible to generalise about cropping systems around Hubli-Dharwad, which has implications for sampling. 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, except in Mandihal where rice dominates. Most crops grown are arable cash crops, particularly pulses, cotton, chilli and orchard fruits.

Figure 9 Cropping systems in Inamveerapur, 2001



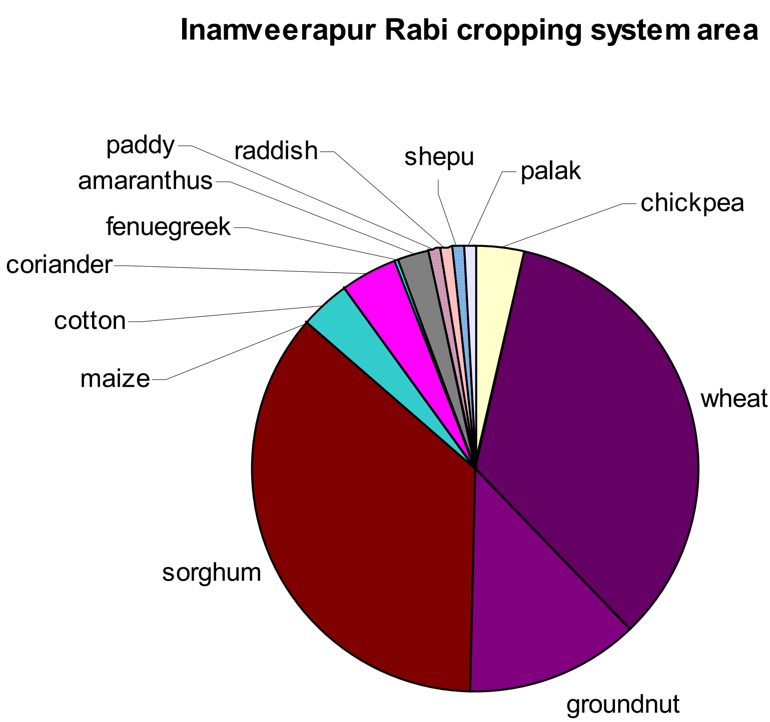
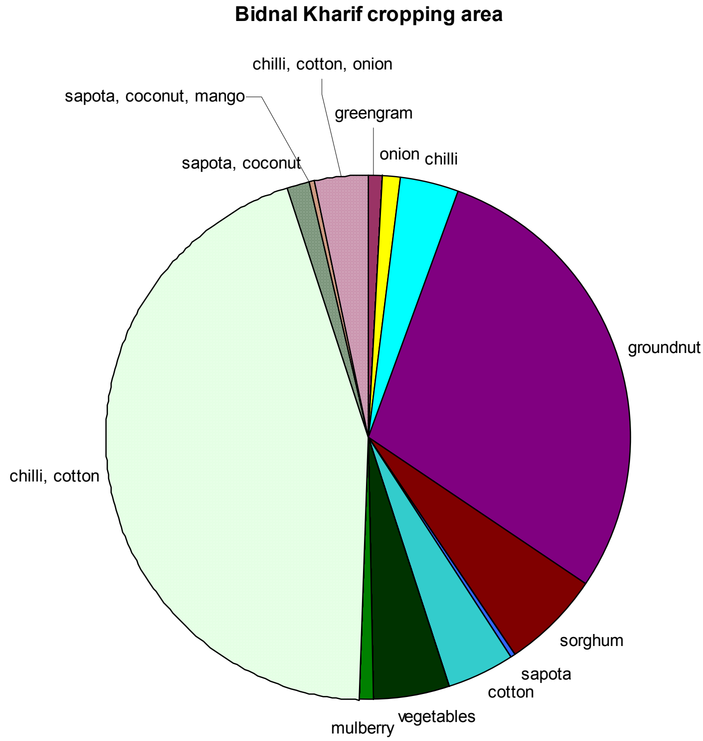


Figure 10 Cropping systems in Bidnal, 2001



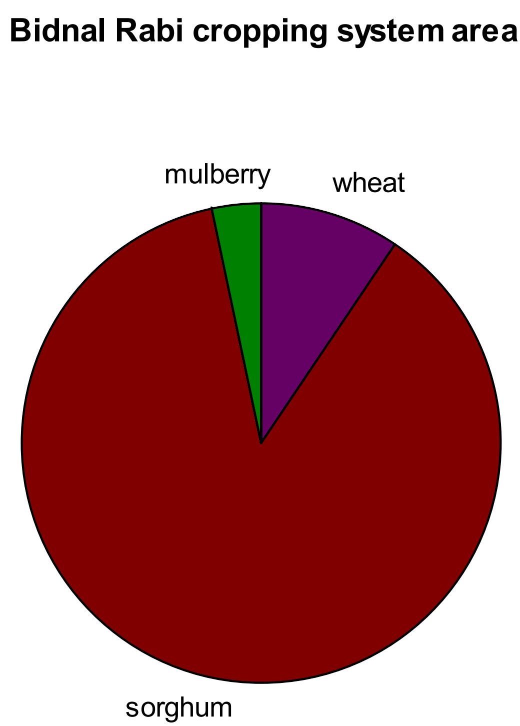
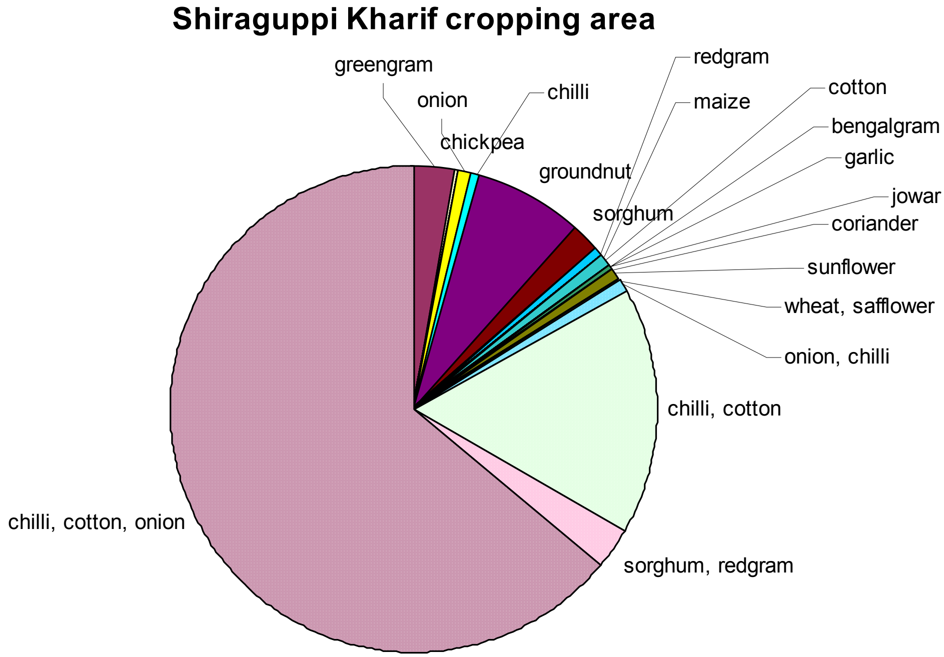


Figure 11 Cropping systems in Shiraguppi, 2001



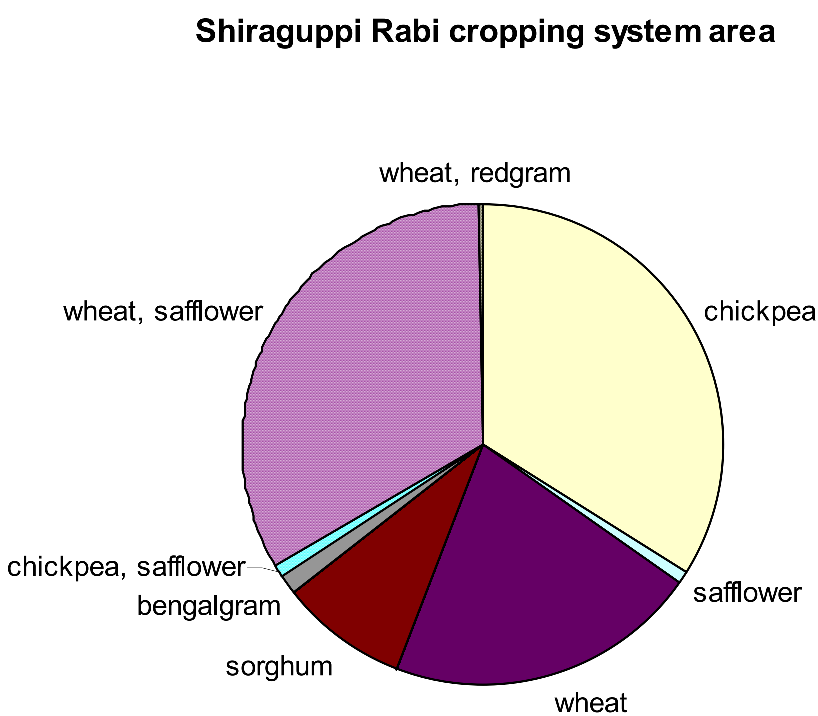


Table 5 Shannon – Weiner diversity index of cropping systems in eight project study villages for kharif and rabi seasons

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**

3.3. Livestock surveys

This was a very extensive survey with 361 respondents across ten villages, and data on a wide range of livestock related activities were collected and entered into the Access database. The discussion which follows is not an exhaustive analysis of all the data, but presents the main findings relative to livelihood strategies and changes to these in the peri-urban interface.

In the time available it was not possible to stratify the sample according to wealth ranking, so size of land holding was used instead. There is a general assumption amongst government institutions that the landless class is poorest and those with largest land holdings are wealthiest. This assumption is examined in Annex B, and this Annex provides evidence that this can be challenged in some parts of the peri-urban interface.

Table 6 presents a summary of dairy livestock numbers, household milk consumption and milk (and milk products, usually curds) sales, broken down by village, land holding class within village, and by time to provide a temporal change dimension. In general, the buffalo is the preferred milking animal as consumers prefer its high cream content. However, cows are also present as they are required to produce bullocks for draft, so these are also milked. Table 6 excludes numbers of upgraded buffalo, as adoption of these is very small, and cross-breed cattle, although these are present in small numbers in many villages. However, milk consumption and sales is from all sources, and is for the year previous to the survey, that is 2000. Farmers were not asked for their recollection of milk sales ten years previously as it was considered that this would be difficult to recall with any accuracy, whereas livestock numbers are well remembered. The issue of accuracy of recollections is an issue with any study involving timelines, but they do indicate trends.

A number of trends can be extracted from Table 6. Mean numbers of local cows are greater in more distant villages (1.40 per household in 1990 and 1.11 in 2001) than in nearer villages (0.88 in 1990 and 0.72 in 2001) and generally there is a decreasing trend over time. Conversely, local buffalo numbers in distant villages are fewer (1.05 in 1990 and 1.31 in 2001) than in near villages (2.05 in 1990 and 2.69 in 2001), but numbers are increasing over time.

Table 6 Main dairy livestock numbers and production per household

Nearer villages								
Bidnal (40)	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**
Landholding	**> 2 ha**		**1 - 2 ha**		**< 1 ha**		**Landless**	
Local cows / household	0.7	0.6	0.4	0.2	0.2	0.5	0.2	0.4
Local buffalo / hh	2.5	2.9	3.2	2.7	1	3.5	3.8	4
Milk consumed (l/d/hh)	3.3	3.3	2.8	2.1	1.8	1.8	2.6	1.1
Milk sold (l/yr)		1140		1170		1350		4000
Gabbur (37)	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**
Landholding	**> 2 ha**		**1 - 2 ha**		**< 1 ha**		**Landless**	
Local cows / household	2.3	1	1.1	0.6	1.7	1.7	0.5	0.7
Local buffalo / hh	1.6	2.3	2.3	4	2.2	4.2	1.1	2.5
Milk consumed (l/d/hh)	2.4	2.3	1.6	1.6	1.6	1	0.7	0.8
Milk sold (l/yr)		786		1900		1260		725
Kelageri (40)	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**
Landholding	**> 2 ha**		**1 - 2 ha**		**< 1 ha**		**Landless**	
Local cows / household	1.8	1.7	2.1	2.3	1.4	0.7	0.8	0.8
Local buffalo / hh	3.1	6	1.1	2.4	2.8	3.3	0.8	2
Milk consumed (l/d/hh)	3.4	4.1	2	2	1.4	1.6	0.9	1.1
Milk sold (l/yr)		2300		1490		1080		730
Dasanakoppa (19)	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**
Landholding	**> 2 ha**		**1 - 2 ha**		**< 1 ha**		**Landless**	
Local cows / household	0.6	0.3	0	0	0.2	0	0	0
Local buffalo / hh	3.7	2.7	2	0	0.8	0.5	0.8	0
Milk consumed (l/d/hh)	2.5	2	1.3	1	0.8	0.6	0.3	0.3
Milk sold (l/yr)		370		0		0		0
More distant villages								
Pudakalkatti (39)	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**
Landholding	**> 2 ha**		**1 - 2 ha**		**< 1 ha**		**Landless**	
Local cows / household	0.7	0.1	0.5	0.3	0.2	0.3	1	0.8
Local buffalo / hh	0.8	1.9	1.2	1.6	1.4	1.8	0.6	1.4
Milk consumed (l/d/hh)	1.8	1.4	0.6	0.7	0.6	0.7	0.5	0.6
Milk sold (l/yr)		620		700		790		430
Shiraguppi (40)	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**
Landholding	**> 2 ha**		**1 - 2 ha**		**< 1 ha**		**Landless**	
Local cows / household	2.4	0.6	0.6	0.2	0.3	0.5	0	0
Local buffalo / hh	2.6	3.3	1.9	1.1	0.7	1	0.2	1
Milk consumed (l/d/hh)	2.9	3	1.7	1.7	0.4	0.6	0.1	0.3
Milk sold (l/yr)		195		318		110		69
Inamveerapur (34)	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**
Landholding	**> 2 ha**		**1 - 2 ha**		**< 1 ha**		**Landless**	
Local cows / household	1.7	2.5	0	0	2.3	0.2	0	0
Local buffalo / hh	1.8	1.5	1	2	1	1.1	1.4	1
Milk consumed (l/d/hh)	1.2	1.2	0.3	1.1	0.5	0.8	0.2	0.6
Milk sold (l/yr)		410		640		230		410
Channapur (40)	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**
Landholding	**> 2 ha**		**1 - 2 ha**		**< 1 ha**		**Landless**	
Local cows / household	3.6	2.9	1.9	1.5	2.1	1.4	1.9	1
Local buffalo / hh	1.6	1.2	0.6	1.5	1.1	0.9	0.7	1.1
Milk consumed (l/d/hh)	1.4	1.7	1	0.9	0.7	0.8	0.4	0.4
Milk sold (l/yr)		230		240		330		380
Varoor (40)	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**
Landholding	**> 2 ha**		**1 - 2 ha**		**< 1 ha**		**Landless**	
Local cows / household	1	0.6	0.1	0.5	0.6	0.1	0.9	1.1
Local buffalo / hh	0.4	0.4	0.6	0.5	0	0.9	0.3	0.3
Milk consumed (l/d/hh)	3	2.9	1.2	1.1	0.5	0.6	1.1	0.9
Milk sold (l/yr)		210		180		245		260
Mandihal (32)	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**
Landholding	**> 2 ha**		**1 - 2 ha**		**< 1 ha**		**Landless**	
Local cows / household	5	4.6	3.9	4.5	1.8	1.8	1.2	1.1
Local buffalo / hh	1.4	1.9	1.2	0.5	1	2.2	1.6	1.4
Milk consumed (l/d/hh)	2.3	2	1.5	1.1	1.2	1.2	0.6	0.6
Milk sold (l/yr)		310		340		510		465

Figures in parenthesis are number of respondents per village

These results show that farmers are investing in buffalo as specialised dairy animals, and particularly so in villages near to the urban centres where access to the markets is better (see Annex C for a description of the milk marketing system). When the data for sales of milk and curds (curds are sold by the villages Inamveerapur and Varoor, as they are too distant to sell fresh milk) are analysed, near four times the quantity is sold from near compared to far villages (1,485 l/y and 393 l/y, respectively). Additionally, milk retail price is slightly higher for milk from near villages (Rs9.1/l) compared to distant villages (Rs7.7/l). Why this is so was not ascertained, but it is known that milk price paid by consumers varies according to the degree of adulteration with water, which may be a factor. Farmers from more distant villagers may resort to middlemen such as Gowlies for marketing (see Annex C) and are reporting price received at the 'farm gate', whereas from near villages most farmers market their milk personally. Data collected as part of the livestock survey (but not presented here) show that in the three villages with HDMC (Gabbur, Bidnal and Kelageri) 95% of the marketing is done door to door in the urban area whereas for the distant villages the figure is 77%. However, the same survey revealed that in the distant villages only 5% used middlemen such as Gowlies which contrasts with results from the marketing survey reported in Annex C, and what is known from experience, so there may be some confusion in the responses in this livestock survey. In the distant villages, local sales within the village were used as an outlet by 18% of households selling milk, so the internal market within villages is not negligible.

On average, a household in a near village earned Rs13,513/y from milk sales, and the much lower corresponding figure for distant villages is Rs3,026. Thus, milk sales play an important role in household livelihood strategies in villages near the city. The exception to this is in Dasanakoppa, where little milk is marketed for reasons noted above in connection with horticultural crops

Households in nearer villages on average consume more milk (1.84 l/d in 1990 and 1.67 l/d in 2001) than those in distant villages (1.07 l/d in 1990 and 1.12 l/d in 2001). This is presumably a function of availability of milk for household consumption, but the decline over time in near villages is an interesting phenomenon.

When broken down into land holding classes, it can be seen that averaged across all villages, the highest number of local cows are owned by the >2ha class, and the least by the landless (in 2001, 1.49, 1.01,0.72 and 0.59 for the four classes of household, largest first). Numbers have declined since 1990. However, the same is not true of buffalo where the corresponding 2001 figures are 2.41, 1.63, 1.94 and 1.47 beasts per household. Although the >2ha land class on average own most animals, the <1ha class own more than the 1 – 2ha class, and even landless households on average maintain over 2 beasts (cows and buffaloes) per family.

Milk consumption figures show greater inequity, however. Ranked from largest to smallest land holding and averaged across all villages, daily consumption in 2001 was 2.39, 1.33, 097 and 0.67 litres. Households with larger land holdings are able to consume more of their milk, whilst landless families have to sell as much as possible. There was a general trend for daily consumption to decrease for all land classes except <1ha class (where it increased very slightly) but the largest decline was for the landless class, down from 0.74 l in 1990.

Milk sales figures disaggregated according to land class (>2ha first) for 2001 were 657, 689, 590 and 747 l/y, averaged for all ten villages. That the landless class should be selling more milk per household than any other class is revealing. Clearly an animal that can be stall fed, and maybe grazed on field bunds if available, is a viable livelihood option for a landless family. For landless families in the three villages lying within the HDMC boundary, the annual quantity marketed increases to 1,818 l, bringing an average income of Rs16,543 (if sold at Rs 9.1/l). In some suburbs, particularly Bidnal, these enterprises are effectively urban dairies, where the mean number of buffalo per household was 4.0 in 2001 and the mean quantity of milk sold was 4,000 l. One landless family has six buffalo, and one family with <1ha has 10 buffalo. Hubli-Dharwad is not self sufficient in milk, and much has to be imported from districts to the north (NABARD, 2000: 35), and in response to this ready market, dairies around the periphery of the city are intensifying as resources to buy new animals permit.

The livestock survey examined sources of feed for livestock, the main points of which are presented here. Grazing and fodder supplies for livestock vary greatly between villages. In the most urbanised village, Bidnal, there was no reported grazing but a considerable amount of 'cut and carry' fodder (dominantly sorghum haulm, but also forage maize and hybrid napier grass) was fed to stalled animals. The main dry fodders used in Bidnal were dry sorghum haulm and blended concentrates, supporting the conclusion that dairying in this suburb is a zero grazing urban activity. Although the proportion of dry cows was ascertained, whether these are taken out of Bidnal for grazing elsewhere was not found out.

Interestingly, in the other two villages falling within HDMC, Gabbur and Kelageri, both of which still have a large proportion of agricultural land and where dairying is also being intensified, the dominant source of food for livestock is natural grazing. In Section 3.2 above it was noted that the proportion of land used for rabi cropping was low, and it appears that these summer fallows are used for grazing of the dairy herds. Many respondents reported that the grazing took place on 'others' land', which is necessary for landless livestock owners. This is supplemented to some extent by dry feeds, predominantly rice husks and conserved sorghum and maize stovers, but in much lower quantities than reported for Bidnal. The other village where grazing was the dominant feeding practice was Mandihal, where adequate grazing land still exists. This is the one village where local cows outnumber local buffalo (Table 6), and this may be linked to the availability of grazing land. A community grazing scheme operates here, with a herder paid to tend the cows by the owners. The only dry fodders used in Mandihal are rice straw and grass hay, both available locally.

In the remaining villages, free grazing appeared to be less important. In the crop growing season livestock were stall fed with forage sorghum and maize, and in the dry season on conserved rice straw, sorghum, maize, and several respondents also reported use of poultry feed. A number of reasons may be advanced for such contrasts in animal husbandry between these villages where dairying is a less important livelihood activity and Gabbur, Kelageri and Mandihal.

Dung is a very important by-product in the Indian rural economy. Every household has a compost pit near the house, and compost is used on the land as fertilizer or is sold if the household is landless. Dung cakes are also used as cooking fuel even in some houses which use kerosene or bottled gas, as it is considered to provide the best temperature for cooking milk. Collection of dung is facilitated by stalling livestock.

In the more distant villages where there are fewer opportunities for work in the city, agriculture is the dominant livelihood activity. As was noted at the end of Section 3.2., in general staple crops occupy less land than cash crops, particularly less perishable species such as pulses, chilli and cotton. Other work (during project R7099) showed that the food security strategy of households with any land at all is to grow sufficient staple crops for household needs for the year, and any other land is used for cash crops. In a semi-arid area such as Hubli-Dharwad, growing staple crops for sale (apart from speciality varieties of rice, for example) is unprofitable in the face of much lower production costs from the irrigated 'grain basket' areas of north India. As relatively little milk is sold from the distant villages, land for cropping has to be fully utilised for growing cash crops once food needs have been met, and land for grazing is presumably a less profitable use.

The other main use for cattle is draft power. North Karnataka is still relatively unmechanised, and even where tractors are owned, bullocks are still preferred for some tasks such as crop sowing and weeding. Surprisingly, the numbers of local bullocks is greater in the near villages (1.72 per household in 1990 and 1.54 in 2001) than in the more distant ones (1.34 and 1.32 respectively), although numbers are decreasing over time in near villages (Table 7). When disaggregated into land holding class, unsurprisingly the farmers with most land have most bullocks. In descending order from >2ha down to landless, the numbers per household in 2001 were 2.70, 1.64, 0.92 and 0.37. Presumably landless households keep bullocks for hire to landed farmers. The highest numbers of bullocks per household are for the largest farmers in Bidnal and Shiraguppi. This is the zone where the profitable chilli – cotton system is practised, and clearly in that systems the bullock is still an important draft animal.

Table 7 Number of local bullocks per household

Year	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**	**1990**	**2001**
Landholding	**> 2 ha**		**1 - 2 ha**		**< 1 ha**		**Landless**	
Nearer villages								
Bidnal	4.5	4.9	3.2	1.7	1.3	2.0	1.1	0.6
Gabbur	2.6	1.9	1.6	1.4	0.8	0.6	0	0.1
Kelageri	2.4	2.4	1.9	1.9	1.0	0.8	0.4	0.4
Dasanakoppa	2.9	2.9	2.0	1.5	1.5	1.5	0.3	0
More distant villages								
Pudakalkatti	1.4	2.6	1.1	1.8	1.4	0.9	0.8	0.4
Shiraguppi	4.6	4.2	1.5	1.6	0.4	0.3	0	0
Inamveerapur	1.7	2.3	0	2.5	1.4	1.1	0.5	0.6
Channapur	2.2	1.9	1.2	1.6	1.4	1.4	0.8	1.0
Varoor	2.3	1.4	2.0	0.8	0.5	0.1	0.9	0.6
Mandihal	2.8	2.5	2.8	1.6	0.5	0.5	0	0

Other livestock are present. Goats are found in small numbers in all the villages except Bidnal, and are largely confined to the landless sector. Goats can be grazed on any waste land or field bunds, and so a land holding is not necessary. There are very few sheep. Some poultry are kept, but few eggs are reported to be eaten. In Kelageri, Bidnal and Dasanakoppa there are intensive poultry units, but only one case amongst the respondents in each of those villages.

Conclusions drawn from the livestock study are:

- Dairying is a major economic activity, particularly near the city and landlessness does not exclude households from this activity, which near the city is intensifying.
- There is a low level of technology, evidence for which is that there are low numbers of improved livestock, and even in profitable farming enterprises bullocks are retained.
- In more distant villages, livestock are generally stall fed to maximise productive use of land for cash crops.
- In villages near the city (Bidnal excepted), grazing is still important, particularly outside the monsoon season, presumably because it is more remunerative for crop growing farmers to work in the nearby city than to grow a low yielding rabi crop.

References

Brook, R. M. (2000) R7549; Consolidation of existing knowledge in the peri-urban interface system. Final Technical Report, NRSP.

Kent, M. and Coker, P. (1992) Vegetational Description and Analysis. Wiley, Chichester, UK.

NABARD (National Bank for Agriculture and Rural Development) (2000) Potential link plan 2001-2002; Dharwad, Karnataka. NABARD Regional Office, Bangalore.

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

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.