

## Urban agriculture in Hubli-Dharwad, India

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### Background

Hubli-Dharwad is a twin city located 425km north west of Bangalore situated on the main highway to Pune, in Karnataka State, southern India. The two city centres are 20 km apart, Hubli being the larger of the two. In the 2001 census, the population recorded was 786,000, and is the second largest urban agglomeration in Karnataka after Bangalore, the state capital.

Over the decade 1981 to 1991, Hubli-Dharwad achieved only modest population growth. In 1981, the population was 527,108, rising by 22.99% to 648,298 in 1991, and by 21.2% to 786,018 in 2001. This level of growth was lower than the average growth rate of 36.27% over the decade for the 21 urban agglomerations in Karnataka State and the national growth rate of 37.28% of the 308 Indian urban agglomerations. Between 1991 and 2001, population growth rate was 21.24%, a slight decline. The twin-city covers an area of 191 sq. km., of which around 40-45% of the conurbation land was developed in 1991, indicating the scope for practising agriculture at that time.

Its population density of 3395 persons per sq. km. in 1991 was relatively low, compared to both the Karnataka State average urban density of 4985 persons per sq. km. as well as the Indian urban agglomeration average population density of 5953 persons per sq. km, so Hubli-Dharwad can be considered to be a city of lower than average population density, partially attributable to the low population density in the space between the two cities, which is now filling up.

It is located in an agricultural area on the western edge of the Deccan Plateau. The climate is monsoonal and semi-arid, rainfall decreasing from 1000 mm p.a. in the west to 700 mm in the east. Most of the rain falls during the south west monsoon, from June to September (The *kharif* season), although in most years there is sufficient rain during the north east monsoon (the *rabi* season) to grow a second annual crop on favourable soils. However, in recent years, drought has been a recurrent problem. Agricultural systems are influenced by rainfall, soil type, availability of irrigation and marketing opportunities. Main crops are rice and grain legumes to the west and cotton, sorghum, chilli to the east. Dairy enterprises are very important close to and within the city. Industry tends to be agriculturally related, such as milk and fruit

processing, although manufacturing is increasing in importance. Dharwad is also an academic and administrative centre and Hubli is an important railway junction.

Administratively, the State of Karnataka is divided into districts, taluks (sub-districts) and grams (villages or cluster of villages) at the smallest end of the scale. The twin-city is in Dharwad District, which, after reorganisation in 1998, has five taluks, or sub-districts. Larger urban areas such as Hubli-Dharwad are managed by municipal corporations which are responsible for sanitation, upkeep of physical infrastructure, and water supply. Hubli-Dharwad Municipal Corporation (HDMC) was formed in 1962. Physical planning is the responsibility of the Hubli-Dharwad Urban Development Authority (HDUDA), and its remit extends to about 10 km outside the boundary of HDMC, to include villages which may be destined to become part of the urban area. HDUDA is charged with developing the Comprehensive Development Plan, regulating development activities and providing new residential layouts. The HDUDA also aims to provide between 10 and 15% of open space for every ward within the twin-city.

The city is surrounded by a green belt, although the boundaries of HDMC are still expanding outwards to accommodate growth of the city. In 2000, a by-pass opened to the west of the city, much of it passing outside the boundary of HDMC, but since then the boundary has been extended westwards to include the by-pass. Around its periphery, much of the land with the HDMC boundary is still agricultural. Additionally, the space between the twin cities consists of farmland, although this area is rapidly being built upon, as mentioned above.

There is still, therefore, a considerable amount of agricultural activity within the boundaries of the corporation. This can be conveniently divided into two categories:

- Remaining traditional activities waiting to be overtaken by urbanization
- Agricultural activities that have arisen as a consequence of opportunities presented by the urban area, such as urban dairies and wastewater irrigated vegetable production.

One form of agriculture that is almost entirely absent, however, is backyard cultivation or growing of vegetables or staple crops on vacant or public land. The land is available for this if people wished to engage in this form of cultivation; there are still many open spaces both within the built up portions of the cities (particularly Dharwad), and in the zone between the cities. The form of agriculture occurring within the built up parts of the cities is almost entirely based on livestock. One reason for this may be that all cultivation in India is performed using ox (or tractor) drawn ploughs, and oxen are absent within the cities. Hand hoes are not used for cultivation, so the small hand-cultivated plots encountered by the author in African and Papua New Guinean towns and cities, are absent in India.

## **Dairying**

Dairying is a residual, traditional activity occurring mainly on the outskirts of the urban area, or it may be specialist urban dairies which rely almost or entirely upon zero grazing techniques which have arisen in response to demand from the urban population. These categories are not distinct, but tend to merge into each other.

In and around the city there are large and small dairies, with the more commercial dairies, of which there are around twenty, keeping between ten and twenty buffaloes and crossbred cows. A number of smaller dairies keep crossbred cattle, but by far the largest number of urban dairies belong to traditional buffalo keepers, known as 'gowlies'. This group keep a breed of river buffalo known as 'Pandapuri' or 'Dharwari'. These are moderately productive animals, yielding 5 to 6 litres milk per day, or 1,200 to 1,800 litres per lactation (typically 305 days). Such buffalo keepers may rely on supplementary urban-based work, but keep one or two buffaloes as a source of milk for their family and as an additional source of income, as well as wanting to maintain tradition and provide a source of security. There are, however, households that rely solely on the milk produced by buffaloes as their source of income. Many of these dairy units are located in the centre of the cities. Buffalo milk is preferred to cows' milk, as it has a higher fat content. However, crossbred cows give higher milk yields than buffalo.

Table 1 presents data on the cattle and buffalo populations within Hubli-Dharwad city, recorded in Livestock Surveys undertaken in 1990 and 1997-98. As can be seen, the figures are high for an urban area. As Hubli is a more commercial centre than Dharwad, there are fewer cattle and buffaloes than in Dharwad, though slightly more crossbred cattle. The number of cows and buffalo are decreasing in the city, though the reduction in the number of crossbred cows does seem surprising if larger, more commercial, urban dairies are opening within the city boundaries. This may, however, be a very recent trend.

**Table 1 Cattle and buffalo population in Hubli-Dharwad city**

Animal	1990	1997/98		Total for 1997/98
		Hubli	Dharwad	
Local cattle	11688	3237	5578	8815
Crossbred cattle	2192	417	238	655
Buffalo	9658	3125	3824	6949
Total	23538	6779	9640	16419

*Source: Livestock census figures<sup>1</sup>*

The main source of fodder for the urban dairies is from the adjoining rural areas, where sorghum is grown extensively. The urban dairies purchase fodder during the harvest season and store it for use during the year. Grasses are also grown and brought to Hubli-Dharwad for sale as fodder. The owners of large urban dairies often have their own resources for growing fodder, including cereals, legumes and fodder grasses. Additionally, food waste from hotels and cafés and vegetable waste is fed to livestock. Open areas within the city such vacant building plots and forested areas are also used for grazing buffalo and cattle when there is an opportunity.

The marketing of milk produced within the urban area takes place quite separately from the rural areas, where the Karnataka Milk Federation (KMF), a quasi-autonomous government co-operative, collects most of the milk for resale. Milk

<sup>1</sup> The 1990 figures were recorded as Hubli-Dharwad city, whereas the figures for 1997/98 were for Hubli and Dharwad cities separately. The livestock census is carried out by survey and is a snapshot of the number of livestock in India.

produced in and near urban areas is sold once or twice a day in the city, depending on demand by consumers. There are several different methods of marketing this milk within the city.

Gowlies sell milk directly to hotels and boarding houses at a price based on the total solids, and to households either from head loads or in cans carried on bicycles or motor cycles. Some gowlies milk their buffaloes in front of the consumers, to assure them of the freshness of the milk and that it is not adulterated. One factor which maintains the popularity of direct marketing is that the vendors can provide bespoke milk, depending on the means of the purchaser. Thus, poor householders can buy milk in small quantities (say, 0.25 litre), and at a low price if adulterated with water. Another marketing route involves vendors collecting milk directly from dairy owners and delivering the milk to organised milk booths in Hubli-Dharwad, of which there are 40 to 50.

The milk collected by the KMF is sold in plastic pouches and this, as well as dried milk, poses a significant source of competition to traditional urban dairies. People can obtain milk when they want it, rather than wait for it to be delivered and its sale appears to be increasing, despite the fact that, in some cases, it is marginally more expensive than buffalo milk. KMF recently began marketing buffalo milk collected from rural areas within the city, which will inevitably increase competition for urban dairies.

There are a number of constraints to keeping buffaloes and cows within the urban areas. These include the lack of space, particularly within the core of Hubli city, which is more congested than Dharwad, declining access to grazing land and drinking and washing water, and a decreasing supply of fodder, as more land around the city is taken for residential, commercial and industrial development. One of the main problems of keeping livestock within the city and allowing them to roam freely for food, is the ingestion of 'foreign objects', from hairpins and coins to plastic bags.

In peri-urban villages on the periphery of the city, but within the HDMC boundary, farmers are investing in buffalo as specialised dairy animals, particularly where access to the markets is good. This can be considered to be a traditional form of agriculture which is now adapting to opportunities presented by proximity to the city. The buffalo keepers are not gowlies, but from the indigenous farming population. They keep a fairly unproductive, nondescript breed which produces 2 to 3 litres milk per day (600 to 800 l per lactation). Nevertheless, farmers are intensifying their dairying activities, particularly those households without land or with less than 1 ha, the average number of beasts per household being between two and four. In these villages, 95% of the marketing is done door to door in the urban area by the farmer or members of the farmer's household. This can be considered to be one route out of poverty for landless people. In those peri-urban villages which have been absorbed into the urban area, and which might more properly be considered as suburbs the dairy enterprises resemble urban dairies; one householder surveyed keeping ten buffaloes, for example.

## **Poultry**

There are 25 or 26 poultry units within HDMC. Many units have been closed due to complaints from the neighbours about pollution and smell. Now the poultry owners

have to get a license from the Municipal Corporation to run a unit (the health officer has to check and then only they are given approval). Most of the units are found around the main highway running through the cities or in peripheral areas as there are not many housing estates there. Generally poultry as an urban farming activity is under threat.

## **Pigs**

Hubli-Dharwad, as in many other cities of South Asia, has a significant number of scavenging pigs roaming free. The keeping of pigs in Hubli-Dharwad has been under threat from the HDMC. In response to complaints about roaming pigs and potential health threats, the Corporation has been rounding up pigs and sending them out of the city, to a forest area around 10km away. The pig owners believe it would be too expensive to keep the pigs penned in and bring feed to them, and hence let them roam free. Most of the pigs are a local, nondescript breed, which are relatively small, and therefore able to scavenge easily.

Estimates put the figure of pigs in Hubli-Dharwad at around 20,000, which roam in herds of between 10 and 500 pigs. The underestimate of the official figures may be due to the owners themselves not knowing the actual number of pigs in their herd, as this can change from day to day, due to births and mortalities, but also owners may be afraid of admitting the real number of pigs owned. The pig owners (or people they have hired) usually go around every alternate day to see whether their pigs are still in their area or they have been lost or increased in their number. When the most productive sows are pregnant the owners pen them in their backyard and feed them with hotel wastes.

Pigs are not welcome in the cities, despite the service they provide in consuming organic waste and nightsoil. Indeed, pigs are generally seen as a nuisance and/or a health hazard. Though they undoubtedly are, the degree to which they constitute a health hazard varies considerably. They also represent a source of cheap protein, for certain social groups which consume pork, as they rely on low cost sources of feed - street rubbish, waste from hotels and restaurants and vegetation. The pigs, or pork, are transported to the consuming markets in Goa and at Hassan, Mangalore and Bangalore, in Karnataka. The pre-Christmas period is the busiest for sales. Traffic poses a significant threat to pigs, especially as they are run fairly quickly and may dash out into a road, giving drivers little warning. The pig owners are potentially facing difficult times, with the actions of the HDMC threatening their livelihood.

## **Sheep and Goats**

Sheep and goat keeping is confined to the outskirts of the twin-city and they are often kept by people who have migrated from villages in search of work in the urban areas. Compared to cattle, buffaloes and pigs, they are a minor component of the livestock population of the twin cities, combined numbers being less than 5,000.

## **Horticulture**

This takes two main forms. Within the municipal boundary, and extending well beyond it, are fruit tree orchards, mostly mango. The other form is vegetable

cultivation irrigated by wastewater flowing untreated from the sewers, which is confined to the city where the wastewater flows are most assured.

### ***Fruit tree orchards***

Fruit tree orchards are increasingly being planted as an investment to reduce tax burdens and as a response to urban influences. The main species planted is mango (*Mangifera indica*), along with smaller numbers of sapota (*Achras zapota*) and tamarind (*Tamarindus indica*). There are many such orchards being planted close to the city, taking advantage of local markets, the existence of a processing plant and of marketing routes to other states in India. The increase in the number of mango orchards around Hubli-Dharwad appears to be due to factors including the fact that mango trees require less moisture than staple crops, increasing the likelihood of getting a good crop in times of increasingly erratic rainfall. Labour requirements are also lower; therefore competing with urban-based employment is not as difficult as for staple crops. Orchards therefore represent a response to urban influence over agricultural conditions, though tax incentives are also responsible for people investing in orchards.

### ***Vegetables***

Within the twin city an estimated 60 million litres of wastewater is generated per day: this flows, untreated, via sewers and wastewater *nallas* (open drains) into natural watercourses that flow into the hinterlands. As water supply to the city improves, this quantity is likely to increase significantly. The wastewater irrigation method utilized along the wastewater *nallas* consists of an overland flow and furrow irrigation system using centrifugal pumps powered by either a diesel motor or grid electricity.

A distinct feature of the intensive vegetable production systems is the all year production of vegetables for sale and the absence of a fallow. Many species are cultivated, including cauliflower, cabbage, onion, amaranthus, tomato, aubergine, okra, chilli, fenugreek, cucumber, radish and beetroot. The proximity to the urban areas – i.e. the source of wastewater – ensures a reliable irrigation supply during the dry season (February – May). The ease of access to local urban markets and high urban demand ensure a secure market for vegetable produce, particularly during the dry season when vegetable wholesale market prices increase between two-fold (amaranthus, cauliflower) and six-fold (tomato). The intensive vegetable production systems require considerably higher labour inputs than field crop systems. Household members normally meet these labour inputs but during peak periods additional farm labourers may be hired.

Although wholesale prices are high, there are considerably increased variable costs associated with wastewater irrigation. A major reason why labour inputs are high is that irrigation with wastewater leads to a dramatic increase in the incidence of weeds and pests which have to be controlled if total loss of crop is to be averted. The increased incidence of pests associated with wastewater irrigated vegetable production arises from a combination of factors. Arthropod pests are habitually controlled by blanket spraying with insecticides; however, the hot climate provides optimal breeding conditions by quickening reproduction cycles, which then enables pests to build pesticide resistance faster. Farmers report multiple pesticide resistance in the main pest species. The planting of vegetable crops in monoculture plots also

facilitates their proliferation, while the continuous cycle of crop production during the dry season when land is normally barren, ensures that insect populations can thrive when they would typically encounter a seasonal decline. However, despite the failure of pesticides to provide effective crop protection, many farmers respond by increasing the frequency of pesticide application, with some farmers spraying twice weekly as they feel they have no other option, and many also mix pesticides, creating potentially hazardous combinations. These practices are advocated by pesticide dealers who are the chief sources of agricultural advice for farmers. Additionally, due to the high nutrient load in the solid fraction of the wastewater, weed growth is prolific, which have to be controlled by hand pulling and hoeing as frequently as every two weeks during the maximum irrigation period.

### **Arable agriculture**

This can be regarded as a residual, traditional form of agriculture remaining until land is built upon. Some villages within the HDMC boundary but on the periphery of the city are distinctly peri-urban in nature; that is, they have both rural and urban characteristics.

In a recent project, cropping systems of three villages which fall within the HDMC jurisdiction were surveyed in detail. In two villages, Kelageri and Gabbur, in the *kharif* season, 79% and 92% of the land is cultivated in the *kharif* season, respectively. The rest of the land is either built upon or classed as 'non-cultivated waste land', and the characteristics of these villages is still essentially rural. Bidnal, on the other hand, is practically a suburb of Hubli, and only 30% is cultivated in the *kharif* season. This low value reflects the area of land occupied by buildings and roads.

In Kelageri, in the *kharif* season the main cropping systems is mango, often with grass underneath or with other understorey crops such as maize and horsegram. Rice, 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 a 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, as owners find working in the city to be more remunerative. In Kelgeri, in the *rabi* season the area cultivated decreased 11.5% of the total village land area (mostly *Dolichos lablab*), indicating the great degree of summer fallowing. This is due to the low water holding capacity of the soil and opportunities to rent land out to graziers.

In Gabbur, the main *kharif* crops are groundnut and intercropped chilli and cotton, and maize. In the *rabi* season, 18.4% of the land area is cultivated, some with sewage irrigation. Although sorghum is the dominant *rabi* crop by a wide margin, numerous irrigated horticultural crops are grown such as cabbage, aubergine, fenugreek, cucumber, amaranthus, and radish. Many buffaloes are kept in the village for milking, and this may explain the extent of summer fallow, as was reported to Kelageri. The buffalo can graze this area at a time when fodder is in short supply. In Bidnal, even though 70% of the land is now unavailable for agriculture, nevertheless, crop

cultivation is still practised, with chilli – cotton intercropping and groundnut dominating the *kharif* season. In the *rabi* season the proportion of land cultivated decreases to 6%. The dominant crop is sorghum. In another village falling within the HDMC area, Navalur, the main *kharif* crop is potato, due to the deep, fertile, vertisol soils there. In the *rabi* season, wheat or sorghum is grown.

The examples given demonstrate that despite being subsumed with the municipality, for many peri-urban villages agriculture remains an important livelihood activity.

### **Official policy towards urban agriculture**

The most important point is that there is no official recognition of urban agriculture, so there are no policies within Hubli-Dharwad that support or encourage this activity. Land-use planning is the responsibility of the Hubli-Dharwad Urban Development Authority, which draws up a Comprehensive Development Plan every ten years or so. Within the plan, land is zoned into different uses. The Authority maintains a green belt around the city, where agricultural land remains, but even in these areas, developers can request changes to the Plan. The green belt is not static either, but moves as the city grows. As the city grows, its boundaries absorb villages which are transferred from the jurisdiction of Dharwad District Council to HDMC.

The urban authorities are charged with maintaining the infrastructure of the urban area, including keeping streets clean and delivering drinking water supplies to urban dwellers. Although these activities may not always be as effective as desired, there is concern that the presence of livestock in the urban areas makes such responsibilities even harder to fulfil. There are, therefore, a number of indications that there likely to be measures taken that will further discourage urban agricultural activities, or even make them illegal. These include the HDMC moves to evict pigs from many areas of Hubli-Dharwad and a Supreme Court Interim Report stating that cattle should not be allowed to roam freely and that cattle sheds should be phased out in cities with a population of more than 500,000. For example, in Delhi there is currently a campaign to rid the city of its stray cattle and illegal dairies.

The Environmental Health officers of the Hubli-Dharwad Municipal Corporation have been attempting to shift hundreds of pigs out of the city for about ten years. The pig owners' association went to the High Court and obtained a "stay", but in 1997 the High Court revised its decision in favour of the Municipal Corporation. The municipality began catching 50-60 pigs per week in 1997. This has prompted some pig owners to sell their pigs before they are seized.

The Municipal Corporation responds to complaints from citizens: if there is a complaint a team is sent to round up the pigs, although the Corporation first announces in the local newspaper that a pig clearance is going to take place. This exercise is being undertaken in Hubli and Dharwad to reduce the "nuisance" caused by pigs: they spoil kitchen gardens and present a traffic hazard especially for scooter and bicycle riders. Japanese encephalopathy - a disease carried by pigs but transmitted by a mosquito which lives in irrigated rice paddies - is not a problem in the city, as there are no paddy fields in the built up areas. There is, however, a perception that pigs pose a threat to health, despite the role they play in consuming nightsoil and other organic wastes.

The police have stopped owners from going into the forest areas to look for their pigs, but they also mislead the owners and tell them that the pigs have been taken to different places to the actual locations. It is possible that the pigs will not survive in the forests, as they are used to easy scavenging in the urban centres. There does not appear to be any obvious resolution to this conflict, unless the pig owners can restrict the movement of their pigs, perhaps by limiting the number of pigs. This would have income implications.

Stall feeding pigs appears at first consideration to be an option which could still make use of wastes, but would involve more labour fetching waste to the pigs which would have cost implications for the owners. Pig owners also believe that the variety of pigs they raise would not thrive if they were stall-fed. The market also prefers the local, non-descript breed of pigs, and the taste of pigs suitable for stall-feeding is considered to be inferior. Moreover, stall-feeding is not being pursued as an option either privately or by the public authorities.

There is legislation regarding keeping livestock in urban areas. The Karnataka Municipal Corporations Act 1976 sets out that permission is required to keep more than ten animals within a corporation area. The annual fee is a minimum of Rs.200 (approximately US\$5), which is paid by poultry and commercial dairy owners. The Act states that dairy and poultry units should not be established in the vicinity of human population in the urban area. Before keeping medium to large-scale dairy and poultry, the entrepreneur has to get no-objection certificate from the neighbours around the proposed unit. If there are no complaints from the people residing around the poultry or dairy units, the HDMC will not interfere in the activities of these units. There are very few officially permitted dairies or poultry farms in Hubli-Dharwad. The HDMC Environmental Health Officer also requires a regular health check-up certificate for zoonotic diseases, which are communicable to human. There are no other policies or legislative measures at present relating to urban agricultural activities.

The body responsible for agricultural production is the Karnataka State Department of Agriculture, which devolves its function down to district and taluk levels. Significantly, the remit of the Dept. of Agriculture ceases at the HDMC boundary. As a consequence, farming activities conducted within the HDMC boundary are not eligible for subsidies nor for favourable agricultural credit terms, yet occupants of houses within HDMC have to pay urban taxes, which are significantly higher than rural taxes.

The official attitude of the Department of Agriculture at State level is that their primary focus is on rural areas. Urban and peri-urban issues are considered to be the responsibility of the Urban Development Department. Urban agriculture should not be encouraged as fertilisers, sewage irrigation etc. cause health problems in urban areas.

At the district level, there is no official distinction between urban and rural farming, but the district agricultural office does not appoint any extension staff to peri-urban villages that come under the jurisdiction of HDMC, and these farmers do not receive subsidies on inputs. There are also specific schemes for disadvantaged sectors (e.g. schedules tribes and schedules castes) which apply only to rural areas.

In terms of advice, urban and rural farmers alike can avail themselves of the *Raita Samparka Kendras* scheme (Farmers Linkage Centres or Agri-Technology Information Centres). These are locations where information is made available to farmers, including through telephone and e-mail. These were started in Karnataka in 2000, and the state now has 745 centres, out of which Dharwad District has 14 centres and Dharwad taluk (sub-district) has four. These are intended to provide any information to the farmers concerned with agriculture and also various schemes, training programmes, etc.

Urban and farmers alike can also participate in *Krishimela* events, which are essentially Open Days at the Agricultural University and its associated research stations. Farmers can meet scientists and discuss and see experiments on the research farm, along with stalls set up by various agencies including the University to exhibit various technologies, machinery, etc.

In terms of policy recommendations, it needs to be acknowledged by the municipal authorities that agriculture does exist with their boundaries. An attitude of studied indifference, disapproval or open hostility is not conducive to allowing agriculture to achieve its potential for livelihood creation, food security and minimizing the environmental hazards that arise. No figures exist for the number of people who are wholly or partially engaged in urban agriculture in Hubli-Dharwad, as this activity does not officially exist, but it must be in the several thousands, if one includes those residual, traditional agricultural activities in the peri-urban zone. There is urban unemployment, and therefore every farmer who derives all or part of their livelihoods from agriculture is one less urban unemployed person.

The policy of pretending that urban agriculture either does not or should not exist results adverse environmental and health hazards, such as irrigation of vegetables with sewage polluted waste water, pigs and cattle roaming free on city roads, and nuisance smells from unofficial poultry and dairy units. Consideration could be given to creating zones where urban agriculture could still be practised, where management practices could be more easily monitored and regulated, but still allowing the urban agriculturists to provide products for the market that are clearly in demand.

More recognition needs to be given to the services that urban agriculture provides. Hotels and food outlets create significant quantities of waste, which is collected by buffalo owners for feeding to their stock, and so relieves HDMC of the burden of disposing of it. Irrigation with sewage waste water, although an undesirable practice, does perform a basic level of sewage treatment, as pumping it onto the land oxygenates the sewage fairly effectively, which is to the advantage of communities who live downstream. Dung is easily collected from stall fed livestock, and this valuable soil amendment reduces the requirements for inorganic fertilizer applications in the peri-urban where it is used, so promotes the accumulation of organic matter in the soil.

Efficient zoning and regulation would provide many benefits in addition to the ones given above. For example, urban dairies could still produce their 'bespoke' milk suited to the financial means of the poor. Veterinary services could be more easily provided, and healthy animals would suffer less and be more productive, so

decreasing costs of production. It would also reduce the number of complaints arising from nuisance smells.

It has to be acknowledged, however, that the pig problem is more intractable. It will remain until their owners accept that there is no alternative to stall rearing, unsuitable though the breed is claimed to be for this husbandry method.

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