Household Food Security and Wastewater-dependent Livelihood Activities
Along the Musi River in Andhra Pradesh, India

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This study focuses on landless and smallholder households who use wastewater generated from the twin cities of Hyderabad and Secunderabad in the drought-prone semi-arid tropics of Andhra Pradesh state, India for various livelihood activities, and the contribution of the wastewater to their food security. Three locations in the urban, peri-urban and rural areas along a river that flows with wastewater were chosen to get a comprehensive view of wastewater use and users. In the peri-urban and urban areas, the income generated by labor on wastewater irrigated fields and by the sale of produce such as vegetables, para grass, palm fronds and banana leaves from wastewater-irrigated fields contributes to the household food security of the wastewater users. All of the vegetable producers surveyed retain a part of their produce for their own consumption and the rest is sold. Many of the leafy vegetable producers engage in barter where they exchange part of their produce for other vegetables to add variety to their diet. In the urban areas, among vegetable producers, 20% of household income is saved because they do not need to purchase vegetables and because they barter their produce for other vegetables. Most of the households in the urban and peri-urban area with livestock use wastewater irrigated para grass as fodder and earn income through the sale of the milk. Typically, 25% of the milk produced (assuming a household of 6 members owns one buffalo) is retained for household consumption and 75% is sold. Many of the urban farmers also grow certain fruits like lemon, mango, coconut and custard apple which they retain for household consumption. In the rural areas, it was found that wastewater-irrigated paddy contributes almost 43% of household food consumption and that households with more than one acre of land and more than five household members grow vegetables like tomatoes, chillies, eggplant and corn for household use on part of their land.

Introduction

In a semi-arid area with frequent periods of drought, wastewater is a critical resource for landed and landless households along the Musi river in and around Hyderabad city, Andra Pradesh, India. This wastewater, which is generated daily by a rapidly growing megacity and which flows into the otherwise dry riverbed, supports a wide variety of livelihood activities that require water. The produce procured directly from these

activities, the produce received by means of barter and the cash income stemming from the sale of this produce are all utilized to ensure household food security. Migrants also gain access to food and income in these wastewater-irrigated areas. If this water were to be diverted elsewhere, most of the adults living along the Musi river would have to migrate to other irrigated areas. However, with the drought and with overdraught, these ground and surface water irrigated areas have diminished in area in Andhra Pradesh. Therefore, the amount of labor employed in these areas has also been decreasing. This study[1] examined urban, peri-urban and rural areas along the river in order to discover the differences by location in the livelihood activities of the varied social groups utilizing the wastewater. These livelihood activities determined their direct access to food as well as their capacity to purchase food for their household members. Dryland farmers, as rainfed farmers are termed in India, were studied as a point of comparison in order to better assess the benefits for household food security derived from wastewater.

Food Security

How does wastewater aid in achieving household food security in the study area? This was the main question that this study sought to address. First, the question of what food security is must be addressed. Food security has been defined thus:

All people have, at all times, access to and control over sufficient quantities of good quality food for an active, healthy life. Food security is based on a combination of these factors: food availability, food access and food utilization (Oxfam and Novib, 2001:6-7).

Food security is integrally linked to livelihoods. The United Kingdom Government's Department for International Development's (DfID) livelihoods framework has identified five types of capital upon which sustainable livelihoods are based: social, physical, natural, financial, human and political (Moriarty, 2002:4). Unemployment and lack of access to assets such as land and water leads to poverty which in turn leads to food insecurity (N.P. Nawani, 1994:2). This is because poor households have less purchasing power to buy food and they often lack assets such as land and water; therefore they cannot produce their own food either. As stated by Oxfam International and Novib:

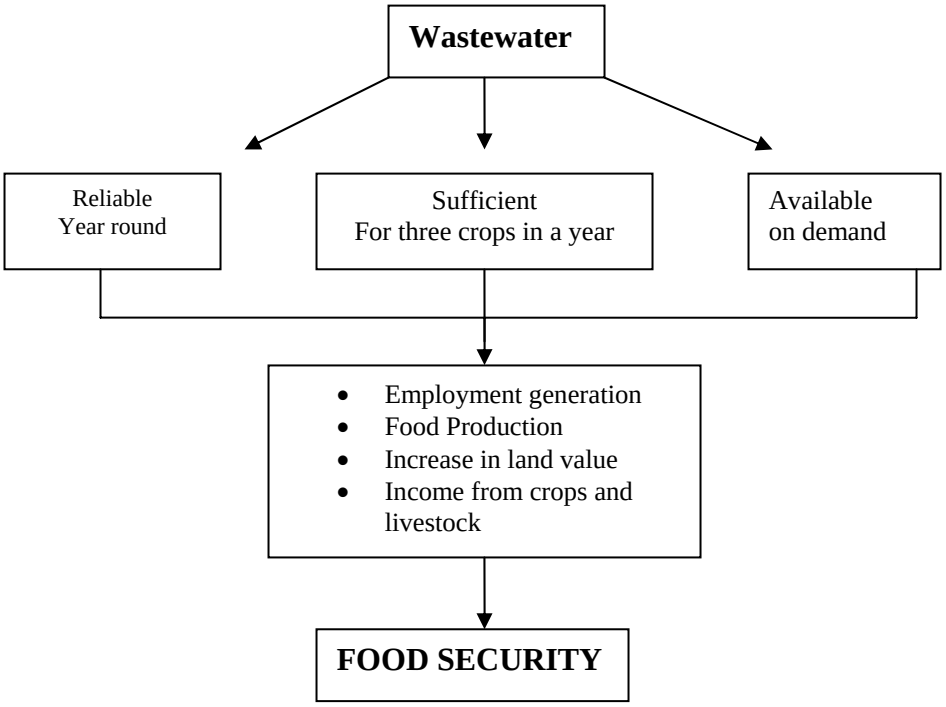
> The right to food is currently embedded in the right to a sustainable livelihood. A livelihood relates to the capabilities, assets and activities required for a means of living. Food and nutrition are inherent parts of a livelihood. People need not only have enough food all year round, but they need:
>
> - To be healthy and well-nourished to work and care for each other;
> - To be educated to participate actively in public life
> - Access to natural resources
> - Access to jobs and markets to make a living

[1] Data collection for this study was undertaken by Stephanie Buechler, Gayathri Devi and Rama Devi of the International Water Management Institute's South Asia office and Umamaheshwar Reddy of Osmania University, Department of Environmental Geology.

- Enough support from family and community so that if there are problems, others can be called on for assistance; and
- The income or other resource to survive bad periods, caused by e.g. deaths in the family, unemployment, bad harvest, or collapsing markets (2001:2).

The majority of undernourished people live in Asia (526 million in 1999). FAO projects that by 2010, 70 percent of undernourished people will live in South Asia and Sub-saharan Africa (FAO, 1999). We argue here that wastewater contributes to food security by providing water for livelihood activities that is reliable, sufficient and available on demand. The flowchart in Figure 1 illustrates the manner in which wastewater contributes to food security.

Figure 1: Contribution of Wastewater to Food Security



Site selection, Sampling and Data Collection

The twin cities of Hyderabad and Secunderabad are located in the heart of the Deccan Plateau at 1760 ft. (536 meters) above sea level and receive approximately 700-800 mm of rain during the short monsoon and cyclone season from June-October. The urban area is 178 square km.; however, with the nine surrounding municipalities this area covers 500 square km. The twin cities of Hyderabad and Secunderabad had a population of 3.7 million in 2001, a 17.2 % increase over the population of 1991 making it one of the

fastest growing urban areas in India (Handbook of Statistics of Ranga Reddy, 2001:157; www.geohive.com/cd2/in_28.php). With the surrounding nine municipalities, the population in 2001 was 6 million. The population projections for 2011 for the twin cities range from 9.5 to 11.3 million people. The research sites outside of the city were located partly in Rangareddy district, which forms the eastern part of the peri-urban area of Hyderabad. This district has seen phenomenal growth in the past two decades with a population growth rate of 60.32 in 1981-91 and 37.41 from 1991-2001. This reflects the fast-paced expansion of the city. The neighboring district of Nalgonda (where the rural research sites were located) experienced a lower population growth rate than the peri-urban area studied. However, the rural growth rates were similar to those of the urban area with 25.11 percent for 1981-1991 and 13.55 percent for 1991-2001. Currently, 145 million gallons of surface water from the Musi river and the Manjira river and 25 million gallons of groundwater is provided to the cities' inhabitants. More water will have to be delivered to this growing area, which will translate into growing volumes of wastewater produced.

The research sites were located along a 5 km stretch of the river in the urban area as well as in 2 peri-urban areas that were 3 and 5 km downstream of the city and 2 rural areas that were 50 and 60 km downstream of the city located on different sides of the river (see Figure 2). Primary and secondary data were collected for this study. Both quantitative and qualitative research methods were utilized to collect the primary data for this study. Household interviews were conducted to gather information on livelihood activities based on the use of the wastewater and income derived from these activities. A structured questionnaire with primarily open-ended questions was used. Portions of the interviews were taped in order to better reflect the opinions of the wastewater users and follow-up interviews were conducted with all of the respondents. For the larger study on livelihoods, a total of 105 questionnaires were applied to wastewater users (one male and one female member of a household) as well as vendors in urban, peri-urban and rural sites. For this study on household food security, a new questionnaire on income and food expenditure patterns were applied in the urban sites, in the Uppal area that is 5 km away from the city and in the village that is 50 km downstream of the city. We applied the new questionnaires to a subsample of the respondents who had been interviewed previously, with the breakdown as follows:

12 households (22 respondents) for the urban sites
12 households (30 respondents) for the peri-urban sites
18 households (36 respondents) for the rural sites

We also applied questionnaires on food security in 13 new households (26 respondents) in the rural site who only own dryland (rainfed land) to get a better sense of the importance of wastewater as a resource in a semi-arid area undergoing a prolonged period of drought.

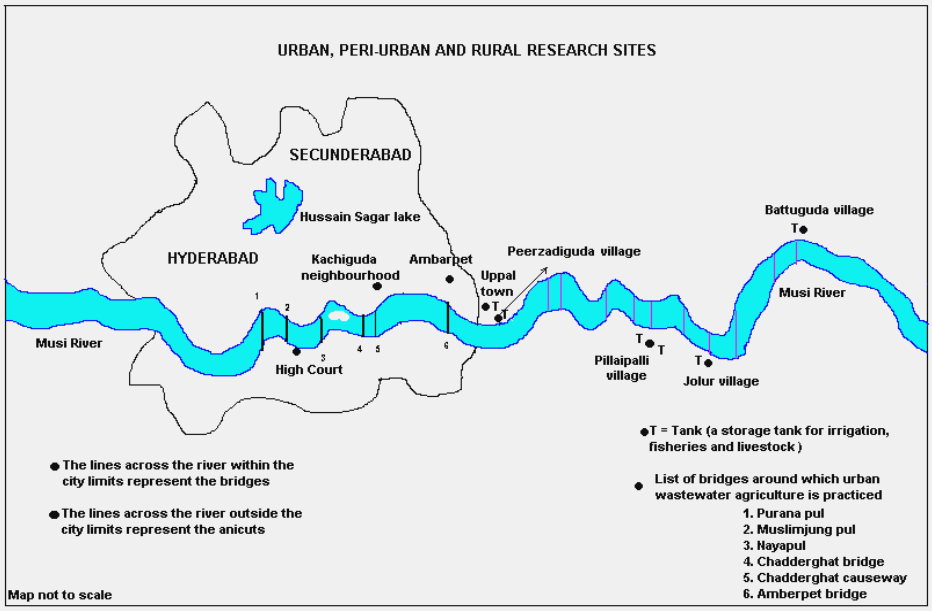
In the urban locations surveyed, landowners, renters, casual laborers, permanent laborers, and caretakers were interviewed. In the peri-urban site, landowners whose main occupation was agriculture, renters, vegetable vendors and renters with livestock were

interviewed. In the rural sites, landowners whose main occupation was agriculture, landless farmers who rented land, dairy producers/farmers, toddy tappers/farmers, fisher-folk/farmers, and casual laborers were interviewed.

Water Quality

Pre-monsoon water quality samples from the Musi river were taken at five points in the urban, peri-urban and rural research sites. The samples were sent for physico-chemical analysis and were also tested for heavy metals. One Quality Assured pre-monsoon sample was tested for Bio-chemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Coliform (MPN/100ml), Total Nitrogen (TN), Electrical Conductivity (EC) Total Dissolved Solids (TDS), Chloride, Zinc (ZN), Copper (CU), Chromium (CR), and Lead (Pb). More frequent monitoring needs to be conducted to get a better indication of water quality in each season. Annex II provides the report on the water quality results obtained by IWMI in 2002. The BOD and COD values were quite low for wastewater in Hyderabad along the Musi river. MPN values indicated high levels of faecal contamination, which increased the health risks of the wastewater to farmers and agricultural laborers in direct contact with it. The risk to the consumer is expected to be lower since none of the vegetables grown are consumed raw. However, no quality-assurance tests were done on the vegetables. The EC and TDS values were higher than those recommended by the FAO guidelines. However, since the major crop is para grass which is able to withstand higher salinity conditions, this water may not have a detrimental effect. Total Nitrogen is higher than FAO guidelines but all heavy metals are within safe limits.

Figure 2: Diagram of study sites



Wastewater from Urban Areas

The twin cities have only one sewage treatment plant (STP) with primary and secondary treatment and one STP that only has primary treatment capabilities. In total, these two

plants treat 133 mld's (113 mld's receive primary treatment only and 20 mld's receive secondary treatment) of water. The untreated sewage water is estimated at 327 mld's. This means that 23% of the wastewater produced by the city receives primary treatment while only 4% receives secondary treatment before it is disposed in the river Musi. For 2011, the sewage load is estimated to rise from the current 460 mld's to 2,560 mld's due to the population increase and concurrent increased inter-basin transfers of river water to Hyderabad to meet rising water demand (HUDA, Draft Master Plan for 2011). Plans for 3 new and 2 upgraded existing plants aim to treat 630 MLD's by 2006.

There are 12 industrial areas within 30 kms of Hyderabad city that include electro-plating, cooking oil mills, lead extraction/battery units, pharmaceutical, leather, textile, paper, soap and jewelry industries. Two of the industrial estates are located near Uppal, the peri-urban area studied. There are only two Common Effluent Treatment Plants (CETP's) and these are not able to treat the effluents adequately due to the many types of effluents received and to the lack of pre-treatment conducted in the industries. The individual industries that do not bring their effluents to the CETP's illegally discharge their waste into wells, into the Musi directly, or into other water bodies.

Wastewater in the Musi River

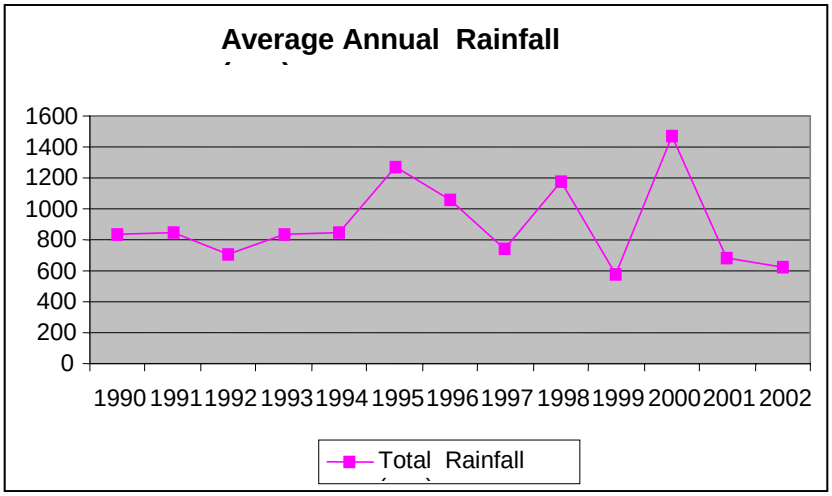
The entire Musi river is located in Andhra Pradesh state. This river originates in the Anantha Giri Hills and flows from West to East across this state. It is a tributary of the Krishna river, a large river that flows out to the Bay of Bengal. The Musi river is used upstream of the twin cities for paddy production and other crops. The remainder flows into a reservoir located upstream of Hyderabad and is used as a drinking water supply for the city. Water from a tributary of the Musi, the Easa river, is also diverted into a reservoir for drinking water, so that there are two reservoirs for the urban area. The Musi river only flows for three months per year during the monsoon season. At Hyderabad, however, the Musi river receives water from the sewage system as well as sewage water that is outside of the purvue of the sewage system. The sewage network only covers 62 per cent of the municipality of Hyderabad. The Musi is now a perennial river due to the year-round inflow of wastewater. The Musi joins the Krishna River in Nalgonda district, a major river that flows out to the Bay of Bengal. However, due to upstream wastewater use, the Musi is usually dry by the time it reaches the Krishna river except when rainfall exceeds normal rates. The area on either side of the Musi downstream of the city is called the Musi belt or 'green belt'.

Wastewater and Livelihood Activities

Initial estimates by the IWMI Hyderabad wastewater program calculated that approximately 40,600 ha of land are irrigated with this domestic and industrial wastewater that flows from the city and from several points downstream. Of these 40,600 ha, 40,500 ha is irrigated with indirect use of mixed treated and untreated wastewater and approximately 110 ha of land are under direct use of untreated wastewater in the urban area. These figures, of course, only give an indication of the extent of the agriculture that can be practiced because of the wastewater. They do not provide a good indication of the other types of economic activities that depend on the existence of this wastewater. The main reason that wastewater is used for all of the

activities is that it is the only water source available except for rainwater during the short and unpredictable monsoon season. Drought conditions have prevailed since 2001 (see Figure 3), therefore dryland agriculture[2] has largely been abandoned in the rural area studied. Groundwater levels have also been decreasing in the whole area (see Table 5) due to overdraught and lower rainfall (The Times of India, 18/11/5). There has been a 20-25% reduction in the area under irrigation due to the drought in the state of Andhra Pradesh in 2002 (government planning discussion, Jan. 22, 2002).

Figure 3: Rainfall Pattern, 1990-2002 near Study Sites



Source: Weather Data recorded at ICRISAT, Patancheru, Andhra Pradesh, India

Table 1: Groundwater Levels for Andhra Pradesh State, 2001 and 2002

	2001	2002
Average depth of groundwater levels	7.52 meters	10.09 meters
Average rise in water levels during south-west monsoon	4.27 meters	0.96 meters
Number of wells	800,000	2,200,000
Area irrigated with groundwater	1,000,000 ha	2,600,000 ha
Percentage of groundwater exploited	16%	43%

Adapted from The Times of India, Nov. 18, 2002.

Table 1 shows clearly the deteriorating situation with respect to groundwater: low recharge rates, decreasing aquifer levels, with higher rates of groundwater extraction leading to a 27 per cent increase in groundwater exploited in the space of one year. Those who have wells must deepen them at great expense and risk since there is no guarantee that they will be able to actually access the groundwater. Wastewater is the only source of water available for agriculture and other livelihood activities that contribute to household food security in this context.

[2] The term dryland agriculture is used in India instead of rainfed agriculture. Since it better captures the conditions under which this agriculture is practiced (very little rainfall) we use this term.

Livelihoods and Crops in relation to the Wastewater System

All along the Musi river there are men and women who depend on the wastewater for a variety of different activities. In the research sites along the Musi river, water for these activities is available because of the existence of wastewater that flows in the river and is channeled to the fields. This flow in the Musi is perennial due to urban domestic and industrial discharge. Livelihood activities based on the availability of water, which in this case is wastewater from the Musi river, vary according to the urban, peri-urban or rural location of the area cultivated. This is due mainly to three factors: 1) the land area available, with the least amount available in the urban areas in the narrow belts of land along the river, and the greatest expanses of land available in the rural areas which is conducive to the production of paddy; 2) the quality of the wastewater; and 3) the proximity to urban markets. Caste/class, gender and religious affiliations of the users also influence the type of wastewater-related activity they will become involved in. Landowners and or/irrigators are only some of the actors who earn and/or save money from these activities. Other actors who derive a benefit from the sale, exchange, barter or retention for household use of various types of agricultural and tree crops as well as livestock, fish and fowl were also studied. These include the landless who rent land with access to wastewater for farming, livestock rearers (who often rent land for fodder production), casual, migrant and permanent laborers, toddy tappers, fishermen, vendors and autorickshaw and truck drivers. These activities contribute to household food security through the income earned, the products derived from and the products bartered for these wastewater related goods and services.

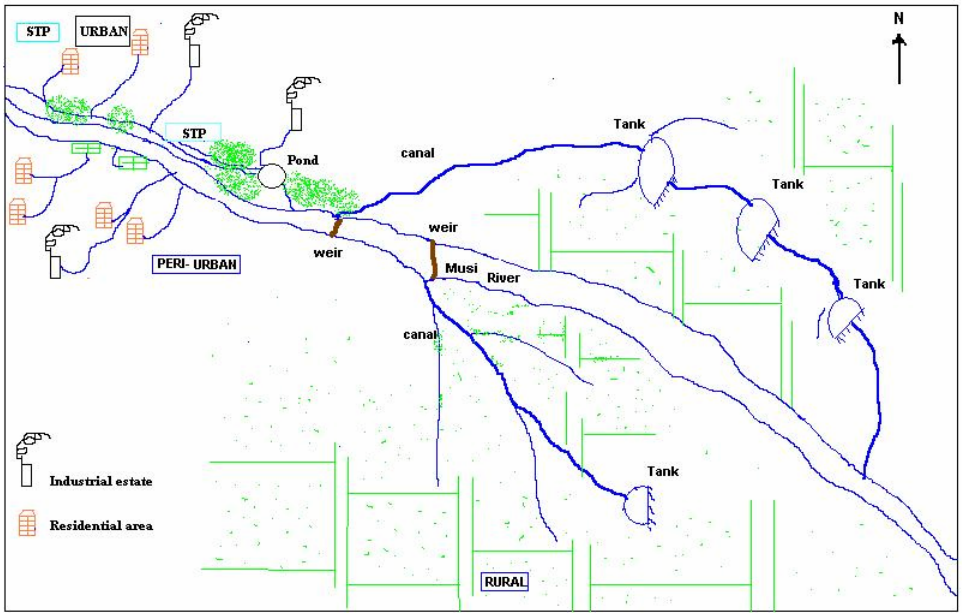
The wastewater channeling and storage methods vary according to location (see Figure 4). Two-thirds of the wastewater from the sewage system is channeled via the sewage system into open sewage drainage canals and into the river or it is discharged directly into the river. In the urban areas, water from the sewage drains empty from spouts in the walls along the city roads into the fields below along the Musi. This wastewater, which is from both domestic and industrial sources (and storm water during the short monsoon season), is channeled to several contiguous plots of land. It sometimes supplemented by water pumped from the river or, less commonly, from shallow wells along the riverbanks. The remaining third of the wastewater is channeled via the sewage system to either of the two treatment plants, depending on the location in the sewage network. Downstream of the primary treatment plant, the water is channeled via a canal and used for agriculture near the treatment plant and also further away to fields in the peri-urban area after it passes through a natural pond where untreated[3] and treated water mix. Most of the area is under fodder grass (para grass) production since fodder grass tolerates higher salinity levels in the water used for irrigation.

Some water reaches the river from the irrigated peri-urban area and some drains from the urban reaches of the river where the drainage canals flow into the river. Wastewater in

[3] There is a diversion canal that diverts much of the wastewater around the primary treatment plant since the capacity of the plant is only 113 mld.

the river is diverted via weirs (or anikuts as they are termed in India) on both sides of the river to main canals which feed branch canals. The water reaches the fields via different channeling methods. One method is direct irrigation from the branch canals or main canals to the fields. Another method, utilized for areas located at elevations that are higher than the river, is where the water is pumped from the branch canals into underground pipes and later directed to smaller channels that go to the fields. In other cases, the river water is directly pumped from the river to fields close to the riverbanks. In still other cases, the water from the weirs is channeled to tanks of varying sizes where it is stored for irrigation then channeled to fields near the tank. Some villages have only one tank and others have several. Some of the tanks are interconnected and are termed link tanks. These link tanks are commonly shared by two or more villages. Many tanks in this Musi belt have water year-round now due to this wastewater. See Figure 4 below on channeling methods.

Figure 4: Channeling methods in urban, peri-urban and rural areas along the Musi river



Urban Livelihoods and Food Security

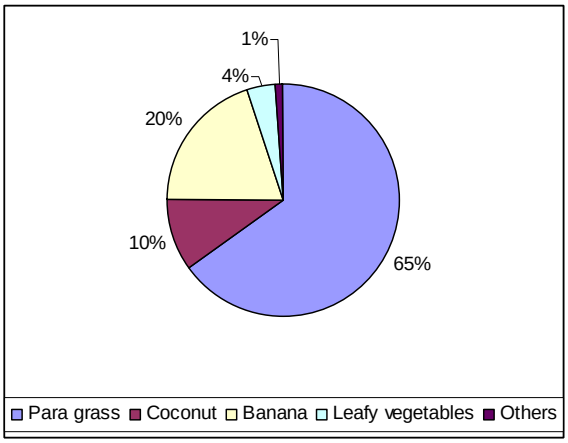
Wastewater in urban areas is used by approximately 250 households for agriculture on a total of about 100 ha of land in the urban area along the Musi river. Most of the urban agriculture is practiced along a 5 km-stretch of the river in the city from the Purana pul bridge to the Amberpet bridge (see Figure 2). It is a green area within a busy area of the Old City and helps to improve air quality.

Types of Crops Grown

A variety of crops are grown in this area (see figure 2). The most common are para grass, green leafy vegetables, banana and coconut palms. Green leafy vegetables are grown on small sections of the land for subsistence needs and for sale in markets that are

in close proximity to the fields. Coconut palms and a non-fruit-bearing variety of banana are also grown for their leaves and are purchased for Hindu ceremonies. These are sold by the caretaker of the land or by the landowner. Other crops include fruit trees such as orange, lemon, papaya, guava and mango as well as crosandra and jasmine flowers used to adorn women's long braids. The fruit from the trees is not sold but is reserved for household consumption or to maintain reciprocal relations, thus saving money. The flowers are also mainly for use by household members. The percentage of land dedicated to these fruits and flowers is low. Para grass, and to a lesser extent *tunga* and *garika* grass, are cultivated as fodder for cattle and buffaloes.

Figure 5: Different crops grown in urban area



The Benefits of Urban Agriculture for Landowner Farmers

In contrast to the peri-urban and rural areas where landowners belong to a multiplicity of caste groups, in almost all intra-urban locations surveyed, the land is owned by a single caste community of Hindus belonging to the *kachi* community now included in the category of Backward Caste or BC [4]. Their forefathers fought in the army of a Mogul ruler, Aurangjeb (A.D. 1679-1707) and upon winning a war in Hyderabad, Aurangjeb gave them land on the Musi river bed for cultivation. Some received the land in later years in return for helping in the hunting parties of the Nizams (the Muslim kings of the then-princely state of Hyderabad who ruled from 1724 until 1952). The names on the land titles are rarely changed even with the death now of several generations of titleholders. Most *kachi*s reside in the Old City of Hyderabad in the *Kachi*guda neighborhood and are members of an association of *Kachi* people where disputes related to, for example, the division of land, are resolved. The average landholding size here is

[4] After Independence in 1947 from the British, four socio-economic categories of people were created to do away with pejorative terms such as "untouchables" for low caste groups and to even out differences between castes by reserving a percentage of seats in educational institutions and government offices for them. The four categories created, from highest economic position to lowest: Other Castes (OC), Backward Castes (BC), Scheduled Castes (SC) and Scheduled Tribes (ST) or indigenous peoples. This system still exists today partly because of ever-prevalent inequalities and partly due to social pressure.

0.4 ha of irrigated land. In the Indian context, these farmers are therefore categorized as small farmers. Urban agriculture with wastewater benefits the landowners from crop income, from fodder grass for livestock, from rental income and from crops used by household members. For one hectare of land, the annual income is approximately €2,812 para grass, € 833 for 1 ha of leafy green vegetables, € 470 for one hundred banana plants, € 33 for 20 coconut palm trees and €2,812 for para grass and €625/ha/year in rental income from para grass.

The landowners who grow vegetables cultivate them using household labor rather than employing caretakers to keep labor costs down. Vegetables require more labor than the other crops grown in this area, therefore only those landowners with sufficient household labor can afford to cultivate them. Most of the household labor for vegetable production is female labor since it is mainly women who do activities like ploughing (for leafy vegetables with a spade), sowing, weeding, harvesting, making small bundles of leafy vegetables, transportation of the bundles to the market in a rickshaw and sale of the leafy vegetables. All of the women who grow vegetables reserve a portion for household consumption and a portion for sale in the urban vegetable markets in the Old City. Women accrue the main benefits from vegetable production since they sell the vegetables in the market or to other market vendors (see Table 3 for income data). All of the respondents reported that the consumption of vegetables in their households had increased in the last 10-15 years. As UN HABITAT has noted, produce from urban agriculture can be an important supplement to the food supply of a family (Okpala, 2002:2).

At least one member of the landowner households contributes to household income from non-farm activities through work as a vendor/owner in a very small grocery store, a railway station newspaper and magazine vendor, salesclerk, teacher, errand boy and electrician. Agricultural income in the urban, as well as the peri-urban and rural areas, is supplemented by non-farm income.

Issues surrounding food security are illustrated through the words of our respondents. A widowed, illiterate 48 year-old female urban farmer has 1 ha of land. On .61 ha she cultivates coconut and bananas and two kinds of leafy vegetables. She retains a portion for herself, her son and one permanent laborer and she sells the rest in the nearby market. She rents out .4 ha for fodder production. She has farmed since childhood and since her husband's death 20 years ago has been single-handedly managing the land. The title of the land is still in her husband's name. She exclaimed that: "We are just able to fill our stomachs due to this land and this wastewater". A landowner with only .2 ha who cultivates banana and coconut trees for the leaves and rents out part of his land for fodder grass cultivation, explained that: "We get our everyday expenses from this land".

Benefits of Urban Agriculture for Dairy Producers

Much of the land dedicated to fodder production is rented to dairy producers from the *yadav* caste who are also BC's. A few also own their own land. They keep mainly buffaloes near their homes in the urban areas for milk production. Many bring their

buffaloes to the river to bathe. Buffaloes provide more milk with a higher fat content for which they receive a higher price than cow's milk[5]. They save money by cultivating much of the feed for their livestock themselves. They derive an income from the sale of the milk from these livestock and they save money by not having to purchase the milk for their household members. The renters with livestock do the harvesting (cutting) of the grass themselves. The men in the family usually do the work in the fields while the men and women raise the animals, milk the cows and buffaloes and sell the milk or curds. They benefit by saving 67 percent on the cost of the fodder by renting the land and growing the grass themselves. One of the respondents who leases .4 ha of land for para grass production for his 8 buffaloes said, "urban agriculture is profitable. In our case, each day we harvest four bundles of grass. It costs us € 0.65/- per day in labor costs. But if the same quantity of grass were purchased from the market, it would cost us € 1.95/- per day." A man from the *yadav* caste who owns the .4 ha of land that he produces para grass for his 20 buffaloes and 2 bullocks on, explained "The quantity [of wastewater] is more now and is also highly reliable. With this water only the grass growth is huge. If this water is cleaned, the grass will not grow so well and it will affect the dairy".

The fodder grass market is an informal market located within 10 minutes of where most urban agriculture is practiced. In the Kachiguda neighborhood of the city where most of the urban farmer/landowners and livestock rearers live, the home minister recently promised 2,000 square yards of land for a new grass market, a symbol of the growing importance of fodder grass production. There are four people who act as salesmen in this informal market and get a commission of 5% for the sale of each grass bundle. On a daily basis, thirty mid-sized vehicles (DCMs) carrying 5 tons each transport the grass to the market. With one full DCM, employment has been generated for 40 casual laborers to cut grass, make bundles and load the vehicle (for which women earn Rs. 30 and men Rs. 40) as well as for one truck cleaner and one truck driver. Therefore, about 1,260 casual laborers, fodder grass salesmen, truck drivers and truck cleaners are employed per day. One salesman, who has been working in the grass market for 20 years, estimated that about 40,000 people along the Musi river either depend on the sale of the fodder grass or depend on the paid labor generated by the fodder grass for their livelihoods. Approximately 50 % of the fodder grass grown is sold in the market. The other half is used directly by farmers who produce it for their own livestock, benefiting, as noted above, a whole set of beneficiaries of renters and landowners from the *yadav* caste.

[5] In India, 45 per cent of the milk produced is buffalo milk (Mudgal, 1999:102).

Table 6: Costs of production and income generated from main wastewater-dependent activities

	Activity	Cost of production per hectare (Rs. and €)	Income (Rs. and €)	Average annual income (Rs. and €)
I URBAN				
1	Agriculture			
a	Leafy vegetables (Rs/ha/month)	Rs. 3,750/ €78 per month	Rs.5,000/€104 per month	Rs. 40,000/ €833 per year
b	Banana (for 100 plants)	Rs. 7,200/ €150 per year	Rs. 22,500/ €470 per year	Rs. 22,500/ €470 per year
c	Coconut (for 100 palms)	Rs.7,200/ €150 per year	Rs. 10,000/ €208 per year	Rs. 10,000/ €208 per year
c	Para grass per ha	Rs. 45,000/ €937 per year	Rs. 90,000-180,000/ €1,875-3,750 per year	Rs. 135,000/ €2,812 per year
d	Para grass (rent collected Rs/ha/month)	NA	Rs. 2,500/ €52 per month	Rs. 30,000/ €625 per year
2	Livestock (for one milch buffalo)	Rs. 500/ €10.40 per month	Rs. 2,000/€42 per month	Rs. 16,000/ €333 per year

Benefits of Urban Agriculture for Casual and for Permanent Laborers

The casual laborers are male or female migrants from a neighboring, drought-prone district in Andhra Pradesh. Some were squatters on the banks of the Musi and were relocated by the government to a resettlement area in the city. Most are BC's. Women find employment for more days per year than men in the urban areas (30 days versus 10 labor days for men). However, like in the peri-urban and rural areas, there is a wide wage gap between women and men. Men earn €1.46 for 8 hours of work, whereas women earn €1.00 for 8 hours of work. Wages are slightly higher for agricultural labor in the urban areas. Female casual laborers tend to work also as housemaids for several houses at a time, earning approximately €9.40 per month and also work as construction workers where they earn €1.25 per day. Men, on the other hand, tend to work mainly as construction workers and earn €1.67 per day. Female casual laborers weed, harvest leafy vegetables and make bundles of leafy vegetables for the market. Men plant, dig channels, level the land and clear garbage that collects on the land from the river, particularly during the monsoon season when part of the land can flood. This work in the fields is physically less taxing than construction work and is therefore preferred by women and by men even though they earn slightly less. A female casual laborer told us that she prefers agricultural labor on the Musi fields to work as a maid because she earns more. She said that "my sister who lives on the river bank with her family as a caretaker tells me whenever labor is required. My daughter takes my place then as a housemaid".

Permanent laborers are men who work on one plot of land year-round. They are from drought-prone states, and return to their home villages for only a few weeks per year. They plant, maintain the channels, irrigate, weed and keep the land free of garbage. They get room and board with the landowner, and a small salary of approximately € 33 per month. Men are hired as permanent laborers due to cultural norms that allow men to live alone without family members and to engage in all types of agricultural labor during all times of day even when others are not present in the fields.

Caretakers and Wastewater Irrigated Urban Agriculture

The caretakers are men or women who live with their families on the land in small huts or tents. They are either *lambadis* which are part of the ST's and are traditionally nomads or they are from the BC. They sell the banana and mango leaves and coconut fronds to customers who come right to the plot to purchase them. The caretakers and their household members derive diverse benefits from their work. They save money since they receive housing for little or no rent. Some caretakers also work on the land for which they are paid the same amount as casual laborers. In our sample, 38.5 per cent of the landowners had caretakers.

In the urban area, the average monthly household income was found to be Rs. 6,340 (see Annex 1) which is higher than the rural area which was found to be Rs. 3,673. Thirty percent of their income is spent on food in the urban area which is lower than the peri-urban area (44.3) and the rural area (66).

Peri-urban Livelihoods

The peri-urban area is undergoing rapid change as urban sprawl extends closer and closer and larger landowners are selling their lands to developers. Smaller landowners are keeping their land in general, however, and larger landowners are still renting their land out for fodder production. There is great diversification of livelihood activities but there are opportunities for the poor still through agricultural labor as well as for the landless from renting small plots of land. This pattern has been found to be common in other peri-urban areas of the world. As Brook and Dávila point out, though, if the poor in the peri-urban areas diversify away from agriculture this could hurt their future food security status (2000:162).

The major caste communities that depend on agriculture in the peri-urban area are, in descending order, the Reddys, Goudas and Harijans. The Reddys are the landlords. They tend to occupy high posts in the fields of education, agriculture and administration. The Goudas have traditionally engaged in animal husbandry. This group comes under the Backward Caste (B.C.) categories. In the peri-urban area, people from the Gouda community completely depend upon buffaloes for milk production. This caste occupies second place in population in the peri-urban Uppal area. The Harijans consist of scheduled tribe (S.T.) and scheduled caste (S.C.) people. They are at the lowest level of

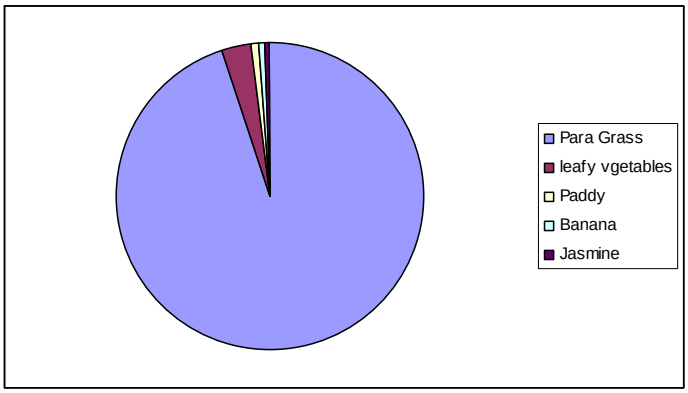
the caste system and are the poorest inhabitants of the Uppal area. The majority have little or no formal education, but find work here as casual agricultural laborers.

In the last 10 to 12 years, para grass has become the main crop grown in the peri-urban area along the Musi river. Paddy cultivation has decreased with only a handful still growing it. The landholding size varies from half an acre to 30 acres. The average landholding in the Uppal area is 1 to 2 acres of land. Only a few farmers have large holdings, which in this area range from 17 to 30 acres of land. There is a farmers' group in the Uppal area that periodically meet to decide labor rates, transportation arrangements and land rents. Meetings take place according to needs that arise or conflicts that surface. The meetings are held near a temple in Uppal.

Today, in 2003, approximately 95% of the cultivated land is used for fodder grass and 3% of the land is dedicated to vegetable production. Of this 3% dedicated to vegetables, 2% is planted with leafy vegetable like spinach, amaranthus, coriander, hibiscus, Indian spinach and sorrel and the remaining 1% is planted with vegetables like potatoes, tomatoes, eggplant, and ladyfinger (okra). Paddy is produced on about 1%, banana on .5% and jasmine on another .5% of the land area.

In Pakistan farmers were able to grow high value crops like vegetables with wastewater (van der Hoek et. al, 2002). In the urban and peri-urban area of Hyderabad the farmers engaged in vegetable cultivation rent small plots of land. Most of the labor involved in vegetable cultivation and sale are women. The vegetables are sold in the surrounding neighborhoods by ambulatory street vendors and by women with stands in the Uppal vegetable market. On a very small percentage of the area, jasmine flowers, banana plants and palm trees are grown. The landholding size varies from 0.20 hectares (1/2 acre) to 12.14 hectares (30 acres). The landowners possess 0.40 to 0.80 hectares (1or 2 acres) of land on average. The chief crop grown is fodder grass. Ten to 12 years ago paddy (rice) was grown. The main source of irrigation was the Musi River, which was less polluted then. Our respondents told us that ten years ago the pollution increased to a point where paddy yield decreased. So farmers shifted from paddy cultivation to fodder grass as feed for buffaloes and, to a lesser extent, cows for dairy production.

Figure 6: Area dedicated to main crops grown in peri-urban area



Para Grass	Leafy vegetables	Paddy	Banana	Jasmine
95%	3%	1%	0.50%	0.50%

Uppal Vegetable Market and Provision of Vegetables for Household Nutrition

In Uppal most of the farmers grow leafy vegetables, since these are the only types of vegetables that grow well with wastewater. The leafy vegetables are grown on small plots of land that range from .05 to .4 ha (1/8 to 1 acre). Each type of leafy vegetable is grown separately on small squares of land with irrigation channels around them. Casual laborers are employed for tying bunches of leafy vegetables and are paid Rs.10/- (0.21 Euro or US$0.22) as labor charges. They work for about two hours in the early morning. Most are women. Vegetables are transported to the market by the farmers on autorickshaws, D.C.M.vans, or private vehicles. Sometimes the farmers directly sell their produce from the fields to the female ambulant vendors who then sell them door-to-door in the village of Uppal. In the vegetable market, vegetable vendors (who are mainly women) purchase the vegetables from the farmers directly at a wholesale rate (7 to 8 bunches for 1 rupee) and sell them to the customer at a higher price (4 to 5 bundles per rupee). The prices for the different vegetables vary slightly. The vegetable vendors within the market use the barter system of exchange. In order to procure vegetables for their households such as potatoes, tomatoes, eggplant and okra that are grown mainly in non-wastewater irrigated areas, they trade their leafy vegetables like amaranthus, sorrel, mint and coriander. The vegetable vendors pay Rs.2/- per day (0.04 Euro or US$0.04) to the Market Municipal Agent for the space provided in the market to sell the vegetables. A wider variety of crops can be grown in the winter (dry) season due to increasing volumes of wastewater from the ever-expanding city. The vegetable vendors earn an average of Rs. 40 to 50 per day (0.86 to 1.51 Euro or US$0.84 to 1.47). The sale of these vegetables is both an income generating mechanism for women and a way in which they can diversify the diet of all of their household members by means of the barter system. 89.5% of our respondents in the Uppal area said that their consumption of vegetables has increased in the last 10-15 years. One couple grows vegetables on land that they own.

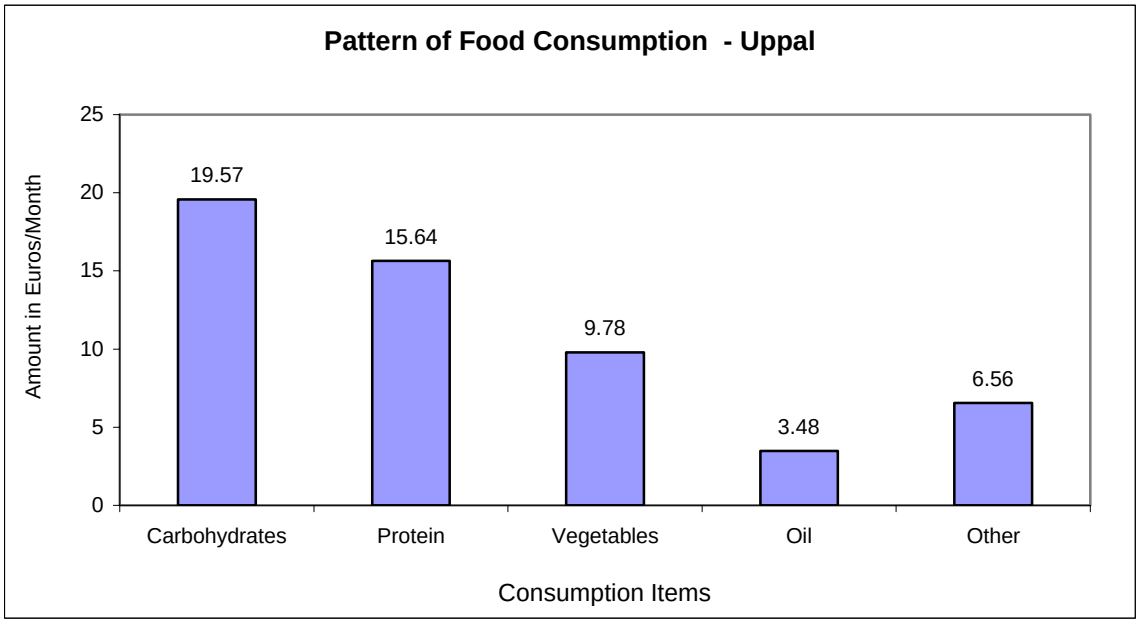
This household consists of 4 members with a son aged 26 doing a Master's in Commerce and a daughter aged 17 years at the junior college level. Both husband and wife work in the vegetable fields. They are able to earn Rs. 3,600 per month. For their own consumption they retain Rs. 200 worth of vegetables and sell the remainder.

Para grass Production

As mentioned above, approximately 95% of the farmers in the peri-urban areas grow grass. Buffaloes are the preferred consumers of this fodder because they provide more milk with a higher fat content, which receives a higher price than cow's milk[6]. The landowners gain an income from the rental of land to those who engage in fodder grass cultivation. The milk vendors lease in grass fields to feed their buffaloes and pay rent that ranges from Rs. 1,000 to Rs. 1,500 per month based on the amount of land and the accessibility of the land to a road. Some renters not only rent the land but also rent the buffaloes that they pay off (in the hopes of one day owning the animals) by selling the milk at lower-than-market rates to the landowners. These are mainly recent migrants. Other groups that benefit from the grass are the labourers who cut the grass. Many of the laborers as well as many of the renters of land and buffaloes are migrants from the drought-prone district of Kurnool in Andhra Pradesh. Both men and women labourers get employment in the para grass fields throughout the year. Unlike with most other crops, there is no gender discrimination in wages paid to the labourers, since in this case, wages are paid according to the number of bundles a labourer harvests. Still others whose livelihoods depend on peri-urban wastewater agriculture are the rickshaw pullers and truck drivers who transport fodder grass to the grass market, the vendors in the grass market and finally the consumers of milk who are mainly the urban dwellers.

One buffalo can produce about 120 liters per month for about 6 months of the year, that is 720 liters. With a household of about 5-6 members, about 180 liters are consumed per 6 months (25% of total milk production). Most dairy producers retain about this amount per 5-6 members (depending upon the age of the members since children drink more than adults) per buffalo and sell the remainder, which would be 540 liters, or 75% of production. Most try to keep more than one female buffalo so that their births/milk production can be staggered with the other buffalo so that milk is obtained throughout the year.

Figure 7: Pattern of food consumption - Uppal



In Uppal, on average, 36% of monthly food expenditure is spent on carbohydrates, 28% on protein, 18% on vegetables and 6% on oil.

Table 7: Inflation and inequality adjusted per capita consumption expenditure

(Figures in Rupees per month)

State/Uts	1983			1993-94			1999-2000		
	Rural	Urban	Combined	Rural	Urban	Combined	Rural	Urban	Combined
Andhra Pradesh	81.59	107.36	87.85	95.62	106.10	98.56	95.57	124.19	104.24
India	78.90	111.01	86.59	87.90	124.27	97.53	98.49	143.49	111.28

Source: National Human Development Report 2001, Table No 2.5, Pg 150

In Uppal (peri urban), the percentage of total income spent on food is 46%. This is slightly lower than the state average for urban areas (47.44 %-see Table 8).

Table 8: Composition of per capita consumption expenditure – Urban

(Percentage)

States/UTs	1983		1993-94		1999-2000	
	Food	Non-Food	Food	Non-Food	Food	Non-Food
Andhra Pradesh	54.57	45.43	53.84	46.16	47.44	52.56
India	58.69	41.31	54.65	45.35	48.06	51.94

Source: National Human Development Report 2001, Table No 2.7, Pg 152

Some water voices from the peri-urban area help illustrate the users' perceptions of the value of the wastewater for household food security:

> This water (Musi water) is polluted, but due to this water only the fodder grass is growing so well. If this water is pure then no grass will come so fast. We have no problem with this water. In fact it is very beneficial. Buffaloes give plenty of milk due to this grass. Our cattle have not shown any signs of ill health due to this grass or water. [Male renter, 55 years old, has livestock and has leased in 2 acres for land for fodder grass production].
>
> We have no problem with this water. Yes, the ground water is polluted and is not potable, but that is a small problem for us and not our priority. If this water was not there, many people will not have any work or livelihood. [Female, 32 year-old, agriculture laborer]
>
> Water density is more and looks as though fertilizers are added and the plant grows to great heights. Little quantities of fertilizers and pesticides are enough for this water. We will grow only leafy vegetables and little quantity of eggplants, tomatoes and leafy vegetables with this water. [Agricultural laborer]

These voices illustrate some of the positive aspects of wastewater use for income and food security as perceived by the occupationally-stratified wastewater users. Some of the positive aspects they identify are good plant growth without much added fertilizers and pesticides.

Table 9: Costs of production and income generated from main wastewater-dependent activities in peri-urban area

	Activity	Cost of production	Income (Rs) (Indian Rs. 48= $US 1)	Average annual income (Rs)
II PERI-URBAN				
1	Agriculture			
a	Leafy vegetables* (Rs/ha/month)	3,750 per month	8,750 per month	40,000 per year
b	Para grass (rent collected Rs./ha/month)	NA	3,720 per month	44,640 per year
c	Para grass on rented land per ha**	7,720 per month	9,920 per month	135,000 per year
d	Jasmine garden per ha***	4,000 per year	7,934 per month	63,472 per year
2	Livestock (for one milch buffalo)****	500 per month	2,000 per month	16,000 per year
3	Toddy tapping	10,000 per year	30,000 per year	20,000 per year

* Vegetables are able to be cultivated for 6 months of the year.
**Depends on location of para grass fields-some near river or canal get flooded, so crop gets lost and grass needs to be replanted. Also, the distance to the road determines how much the buyers will pay for the grass. Four months of the year (winter, dry season) they get less grass.
***Jasmine is able to be harvested for 8 months/year

***Buffaloes produce milk for about 6-8 months after giving birth so dairy producers try to stagger conception of their animals.

Rural Wastewater Users

The majority of those who depend on the wastewater in the Musi river live in rural villages. In these areas, in addition to agriculture and livestock, toddy tapping and aquaculture is also made possible by the existence of this water. One of the rural villages selected and discussed here called Pillaipalli is located in Nalgonda district, Andhra Pradesh and is slightly less than 60 km from the state capital. It has a population of about 5,000 people. The total land under cultivation is 2,575 acres. Land under direct canal irrigation is 297 acres. The land irrigated by Musi water pumped from the canal is about 100 acres. But only 50 of the 100 acres are registered and a land tax is paid. The landholding size ranges from half an acre to two acres of land. There are only three farmers in the village (all three are Reddys) who have between 20 to 30 acres of land.

This village has people belonging to many caste groups. The majority are *goudas* (whose traditional occupation is toddy tapping and they are considered to be a low caste) followed by *harijans* (Scheduled Castes and Scheduled Tribes) and finally the *kaapus* (Reddy community who are generally large farmers and village heads). Migrants from neighboring areas with dryland farming (rainfed agriculture) set up tents and work as laborers to harvest the paddy three times a year. Non-farm activities include basket weaving, truck or auto driver and sari embroidering.

Agriculture as a Wastewater-dependent Livelihood

Under canal wastewater irrigation, people have been growing paddy for many decades. But in the last 10 years more and more people have dug bore wells on their dry lands or have bought pump sets to pump water from the Musi canal and are cultivating only paddy. Their innovation was to grow only two varieties of rice, ones that grow best with wastewater. In May 2002, the paddy farmers got Rs. 430 for 1 quintal of paddy from the rice mill owners. According to the farmers in this village, the rice grown with this water gets spoiled faster than the rice grown from borewell water. The percentage of broken grains is also very high (after milling the paddy). The farmers said that although the crop appears very healthy and grows really fast (in about half to two thirds of the time) compared to others grown further from the river with groundwater, the final yield (the amount of grain form the paddy) has drastically decreased. They describe these conditions with terms such as *"thalu povadam and gousu povadam"*. The first term means that the percentage of grain in paddy is very low. The crop seems very healthy, but the grain yield is less. The second term means that the crop grows much larger than the normal size. By the time the panicles start to ripen the plant stoops into the water below, unable to hold its own weight. This was corroborated in a pilot study consisting of soil and paddy plant sampling in the peri-urban area and analyses conducted by IWMI and more need to be conducted (Simmons, Ensink and Buechler, unpublished).

All the agricultural inputs are purchased either from Gatkhesar (the neighboring mandal, 12 km from the village) or from Pochampalli, the mandal headquarters. The local market for sale of the produce like paddy is Bongiri which is 30 km away.

In the past ten years, there has been a gradual reduction in the cultivation of vegetables. Very few farmers cultivate vegetables on a commercial scale today. The reason given by most is that vegetables need more hired labor as well as more family labor than rice. However, many of the small farmers used a small part of their land for vegetable cultivation for household consumption. The vegetables that are grown are tomatoes, chilies, mustard seed, beans and some leafy vegetables like spinach, amaranthas, hibiscus and coriander. In the transplanting and the harvest season, migrant women, men and children come from neighboring dryland farming areas to work in the paddy (rice) fields. They set up tents in this and other wastewater irrigated villages and number as many as 250 people per village. For the transplanting, the women earn less than the men (about Rs. 40-50 and 70 respectively) for the same work. At harvest time, laborers are paid in kind (in rice). Groups of migrants from the same dryland village come and work together under a contractor who is also from that same village. The migrant laborers divide the rice among them. Forty labor days per acre are required for harvesting. Typically, about 15-20 laborers will be hired to work on one acre of paddy. The contractor receives about 5 bags (there are approximately 70 kg per bag) of paddy (rice with husk still on) per acre. Each laborer receives approximately 17 kg of paddy for harvesting one acre. At the end of the harvest season, each laborer carries home about 2 bags or 140 kg of paddy. A household with 5-6 members consumes about 12 bags of paddy in one year, or about 7 bags of rice. Therefore, husband and wife laborers would each have to work on approximately 12 acres for their household of 5-6 members to be able to have enough rice to eat for a year. Often, another household member will also work in the fields if they are old enough. Table 10 below shows that the food index in general for agricultural laborers in AP has risen since 1996.

Table 10: Consumer Price Index Numbers for Agricultural Laborers in Andhra Pradesh
(Base: 1986 – 87 = 100)

Year	Food Index	General Index
1996 (Annual Average)	258	255
1997 (Annual Average)	274	273
1998 (“)	308	300
1999 – 2000* (“)	324	314
2000 – 2001 * (“)	323	319
Linking factors	5.07	4.48

* Relates to financial year.
Source: Labor Bureau, Simla, and Govt. of India.

Rental agreements in the rural areas studied (Pillaipalli as well as another village 10 km downstream) are also negotiated on an in-kind payment basis. Eight bags per acre of paddy are paid to the landowner by the renter. This has a cash equivalent of Rs. 3,600 (Rs. 450 per bag of paddy). Rentals have a positive effect on the food security, therefore, of the landowners and the renters. As one farmer who leases land for paddy told us:

> We get 20-25 bags of paddy per acre of which 8 bags are given to the owner of the land. With the remainder, 4 bags are given to the labourers and then we have just enough for our household. There are no profits, only household food security.

Table 11: Composition of per capita consumption expenditure – Rural

(Percentage)

States/UTs	1983		1993-94		1999-2000	
	Food	Non-Food	Food	Non-Food	Food	Non-Food
Andhra Pradesh	60.24	39.76	59.59	40.42	60.50	39.50
India	65.56	34.44	63.18	36.82	59.41	40.59

Source: National Human Development Report 2001, Table No 2.6, Pg 151

Eleven of our informants in Pillaipalli responded that their consumption of vegetables had increased in the last 10-15 years, 5 stated that this had remained the same, and 2 answered that their consumption of vegetables had decreased.

When asked about the quality of the water, a typical answer was similar to the one given by this 35 year-old male agricultural day laborer who had migrated with his wife and four children from another village in Nalgonda district one year ago. He had identified the source of the water as the city drains and industrial water. His answer regarding the quality was the following:

> We don't have any problems with this water. In fact, due to this water, so many people are able to fill their stomachs. People say that this is chemical water, but we have not had any problem due to this water until now. We would not have migrated to this village if this water was not here and if this water is stopped we will have to migrate to some other village.

Irrigated agriculture (in the form of wastewater in this village) acts as a magnet for those from non-irrigated areas. However, the quality is of concern to the users and thus far they have not received agricultural extension on how to mitigate the risks associated with its use.

Toddy tappers

Palm trees are grown all around the fields and the tank bunds for toddy tapping. The roots of the trees obtain water partially from wastewater irrigation in these fields and from the wastewater in the tank. There are 160 members in a toddy tapper society in this village. A fee of Rs. 15 per tree is paid per year to the society and another fee of Rs. 1,500 is paid to the society upon entry of the individual into the society which is usually upon the death of a toddy tapping member of the family. There are no female toddy tappers. Women cannot have access to palm trees unless they become a widow. Because of proscribed gender roles, they rent out the tree then to a man to tap the toddy. There are provisions for widows from the toddy tapper society in the event of her husband's death due to toddy tapping. Each toddy tapper has access to a certain number of trees that are not necessarily on their own land. They pay rent to the landowner of Rs. 50 per month. They climb up the tree, having been trained at this since childhood, and tap the liquid that

is drunk unfermented or fermented into an alcoholic beverage from this particular type of palm. The best yield is from February to April when one tree yields 15 to 20 bottles per day. The peak demand for toddy is in the summer. In winter, demand is low. The gear that the toddy tappers use for climbing trees and tapping toddy costs approximately Rs 2,000 and lasts for at least three years. They earn Rs. 10-15 if they sell the toddy in the village or Rs. 5-10 in bulk to contractors who buy the toddy. In one year they can earn approximately Rs. 14,400. They usually combine toddy tapping with other income-generating activities such as farming of small plots of land or leasing land and animal husbandry, also on a small scale. The quality of the toddy from the trees grown near the wastewater-fed tanks or the wastewater-irrigated fields is considered by both consumers and toddy tappers to be good. No problems with the trees, the fruit or the toddy were reported. Wastewater enables these trees to grow in abundant numbers in areas that would otherwise be too dry.

Livestock

India occupies number one in world milk production with output in 1999-200 (marketing year ending March 2000) forecasted at 78 million tonnes. Moreover, the annual rate of growth in milk production in India is between 5-6 per cent, compared to the world's at 1 per cent. The steep rise in the growth pattern has been attributed to a sustained expansion in domestic demand, although per capita consumption is modest - at 70 kg of milk equivalent (www.indiadairy.com).

Andhra Pradesh has seen some dramatic increase in milk production over the last two decades. There has been a 7.9 % increase in the population of female buffalos in 1999 over 1993 (Directorate of Economics and Statistics, Andhra Pradesh, 2001). The milk production of Andhra Pradesh in 1991-92 was 2943,000 MT and 4261,000 MT in 1995-96. The present milk production is 4904,000 MT (www.nddb.org).

Water buffalos, cattle and goats are given either wastewater or borewell water that is also used for domestic purposes. The number of animals a household has depends on the amount of household labor available to take the animals out to pasture and to milk the buffalos or cows. They are kept to supply the household members with milk and those with more children tend to keep more animals. They are also raised for cash income by women who are the main milk vendors and as an investment for possible future expenses. During the summer months when water in tanks is scarce and some animals in non-wastewater areas sometimes die from thirst, these animals have water year-round. The fodder that is fed them, called para grass, is irrigated with wastewater. In this village, this para grass is either grown on the residual moisture around the wastewater and rainfed tanks, or is purchased from the grass market in the city. Much of the grass from this market is grown in wastewater-irrigated fields in the urban or peri-urban areas along the Musi river (interviews with grass vendors, city grass market, April and July, 2002). One family also keeps ducks on the Musi river. They sell the eggs to buyers from the state of Kerala. They are nomadic and follow the ducks. They have initiated this livelihood activity due to the fact that they have only rainfed land and were not able to sustain

themselves from agriculture on this land partially because of two years of failed monsoon rains.

Fishing

The fishermen in this village belong to the *Muthrasi* caste. They have a society of which men from all 12 *muthrasi* households are members. Almost all the fishermen in this village are marginal farmers or renters of land for subsistence rice production with their main income derived from their own and other household members' agricultural labour. Some of the fish (approximately 25%) is sold within the village at the following prices: *korra mattalu* at Rs. 50, *nalla cheap* at Rs. 40, *bocche* at Rs.20 and *ravvulu* at Rs. 25 per kg. The *bocche* fish survives the best in the Musi tanks but also fetches the lowest price per kg. The trader after deducting the cost of the seed pays the remaining amount to the society of the fishermen. This amount is equally divided among the members. On average each member receives Rs. 1500 per harvest depending on how large the fish grow. It is not necessary that the fish is harvested every year. Sometimes the fish is harvested once in two years if the size is not big enough.

The village has a 60-acre tank fed by the Musi water as well as three rain-fed ponds (9, 16 and 9 acres respectively) and one rain-fed tank. The rain-fed tanks are almost dry and the tank which is filled with Musi water does not hold much water since it has become shallow due to silting. Desiltation has not been carried out in years. Siltation was also a problem cited by farmers in other rural villages that we visited in Nalgonda district. This lack of sufficient water in the tanks presents problems for agriculture and for aquaculture. As one fisherman who also has 1/5 of an acre of land planted in paddy for subsistence needs in Pillaipalli expressed it:

> I don't think that there is much problem with the quality of this water. But as a fisherman my problem at present is not the quality of the water but the silting of the tanks. They have become very shallow and fish cannot grow to a big size here…Since the tanks are shallow the water overflows into the canals.

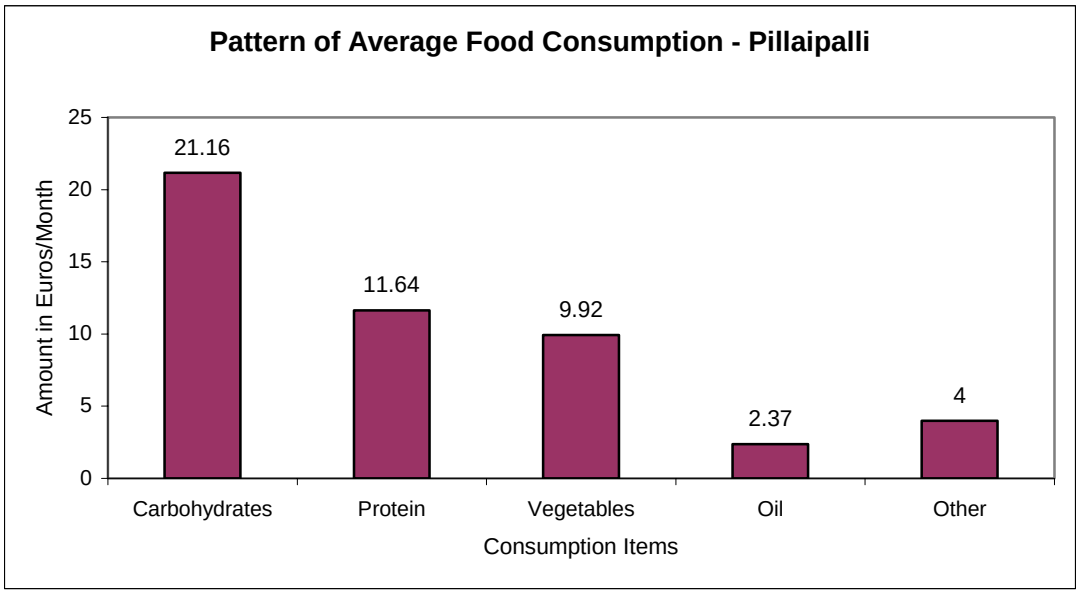
However, the situation in the Musi fed tank is slightly better than the rainfed tanks. Since there has not been enough water in the rainfed tank and the rainfed ponds due to insufficient rainfall, fishermen have gotten permission to put all of the seed into the Musi river wastewater-fed tank. See table 12 below for a comparison of income derived from the main rural livelihood activities.

Table 12 Costs of production and income generated from main wastewater-dependent activities in peri-urban area

III RURAL				
1	Agriculture	Costs of Production	Annual average income	Total average income minus costs of sproduction
A	Paddy per ha	11,250 per crop	23,750 per crop (2-3x/yr)	47,500-71,250 per year
2	Livestock (for one milch buffalo)	300 per month	1,440 per month	16,000 per year
3	Toddy tapping (for 8 palms)	10,000 per year	30,000 per year	20,000 per year
4	Aquaculture (Rs/year/fisherman)	500 per year	1,500 per year	1,000-1,500 per year

Among our respondents in Pillaipalli, the major part of their expenditure on food is on carbohydrates, followed by protein, then vegetables and lastly, oil.

Figure 8: Pattern of average food consumption – Pillaipalli



Rainfed Farming in Pillaipalli

What about the farmers without access to wastewater or groundwater in this village? How do they survive economically? Do they try to gain access to the wastewater? The responses to these questions offer a clearer picture of the importance of wastewater to farmers. Seventy farmers who own land in this village do not have access to any type of

water for irrigation. They farm a total of 120 acres of private, cultivated land. When the rainfall during the monsoon season is sufficient, the dry land farmers are able to cultivate castor, sorghum, bajra, chickpea, groundnut and other pulses.

As mentioned above, in 2001 and 2002, there was below-normal rainfall with concurrent reductions in groundwater levels. The dryland farmers in Pillaipalli, therefore, have left their lands without growing any crop and have taken Musi-fed lands on lease, or have purchased livestock or increased the number of hours and the number of household members who work as laborers. There are no migrations from the village because the Musi wastewater is available. However, some members of the family opt for non-farm employment as teachers, R.T.C. conductors or as drivers for trucks or autos. The dry lands (rainfed lands) are very rarely given for lease and, if given at all, only for fodder grass. The amount for lease is Rs.250/- for 1 acre per year. More than 200 acres of land with access to wastewater is leased in Pillaipalli for fodder grass production. There is no caste distinction for leasing the land. This year, no rain fed crops were able to be harvested. However, there is a lot of demand for rain fed fodder grass and Musi irrigated fodder grass. The dry grass of the paddy plant is also used as dry fodder. The remaining paddy plant grass is sent to the city, and the farmer is able to earn Rs.1, 500/- to Rs.1, 600/- per acre per crop. At present, approximately 15% of the population depends upon rain as their only source of water for irrigation. A minority of rainfed farmers are from the Reddy caste community (high caste) and have a vast area of rain fed lands, with the plot size varying from 10 acres to 60 acres. The average size of rain fed lands is 3 acres. Dry lands are mostly inherited land and are situated at a high-elevated topography, which are 1 ½ to 2 km away from the Musi canal. Some of the farmers are converting these lands into Musi-irrigated lands by reducing the height of the field through levelling, then pumping the water. Paddy is grown on these newly irrigated lands.

Comparing Actors and Activities Across Wastewater-Irrigated Areas

In the peri-urban and rural areas studied, all of our informants were found to be above the state and the national poverty line (refer to Annex I). In the urban area, 17 per cent of our informants were found to be below the poverty line. There are many differences between the locations in terms of livelihood activities and the actors who engage in them. The cropping pattern is more diverse in the peri-urban than in the rural areas. The greatest amount of employment for women is generated in the peri-urban areas with vegetable production and sale and in the rural areas with paddy production (mainly with transplanting, weeding and harvesting). The broadest range of livelihoods based on wastewater is undertaken in the rural areas. The tables 6,, 9 and 12 enables easy comparison between the peri-urban and the rural activities with their respective costs of production and income per month and per year. Table 12 give an indication of the income derived from and the cost of production involved in many of the activities studied.

Jasmine and livestock are the most lucrative activities in the peri-urban area and livestock and toddy tapping are the most highly remunerated activities in the rural areas. The greatest heterogeneity can be found among the peri-urban and rural wastewater beneficiaries.

Table 13: Wages Across Locations for Casual and Migrant Labor

•URBAN
–Male Rs 70/- for 8 hrs work (10 labor days)
–Female Rs 50/- for 8 hrs work (30 labor days)
•PERI-URBAN
–Male Rs 80/- 8 hrs work (250 labor days)
–Female Rs 50/- 8 hrs work (250 labor days)
•RURAL
–Male Rs 70/- 8 hrs work (100 labor days) or for paddy harvesting: 17 kgs paddy/acre
–Female Rs 50/- 8 hrs work (100 labor days) or for paddy harvesting: 17 kgs paddy/acre

The greatest amount of employment is generated in the peri-urban area with para grass and vegetable cultivation. Paddy cultivation does not generate as much employment (grown primarily in the rural areas). However, for the landowners who grow paddy, it does ensure a degree of household food security because they retain a portion of their rice for self-consumption. For a household with 6 members with one acre of paddy, they would consume about 23 per cent of what they produce and be able to sell or barter the remaining 77 per cent. Casual laborers (from the village as well as from other villages) also achieve food security in rice from work during harvest time because they are paid in kind (paddy). Furthermore, lower expenditures of family labor time and on paid labor (than vegetables or para grass, for example) mean lower costs of production for producers. The government has maintained a minimum support price for rice, encouraging its production. Andhra Pradresh state is considered to be the rice bowl of South India. Rice occupies 67% of the irrigated area in the state (Mohammad, et. al, 1998:4). Women earn less for their labor than men in all locations.

Conclusions

The research findings from this study clearly show the importance of wastewater for the livelihoods of various groups of people. In many areas of the world, including in this study area around Hyderabad, wastewater is the only source of water available in sufficient quantities throughout the year. The landowners as well as many others derive their daily sustenance from wastewater-related activities. The sale of vegetables in the wastewater-irrigated areas is controlled by women and improves their ability to gain access to a wider variety of vegetables for themselves and their household members. In all of the areas surveyed, the majority of the respondents reported that their consumption of vegetables has increased in the last 10-15 years. This is due to the availability of vegetables in this wastewater-irrigated area, income generated through wastewater-related activities, as well as to a growing consciousness about the health benefits related to their consumption. Rice provides food security to those who grow it on their own land or on rented land and to those who are hired as laborers and are paid in paddy. Para grass, which is consumed by the buffaloes of dairy producers who own or rent wastewater-irrigated land, provides food security to these dairy producers in kind (in the form of milk) and in the form of cash from the fodder grass and/or milk. It also provides cash income from wage labor. Policymakers must not turn a blind eye to the integral connections between household income, wastewater-related livelihood activities and household food security.

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Annex I

URBAN

S.No	Category	Income pm	% of income spent on food	% on carb	% on protein	% on veg	% on oil
1	Land owner	13660	15	26	29	18	8
2	Renter	7750	34	52	18	14	6
3	Watchman hh	2450	31	49	23	13	5
4	Permanent laborer	1500	38	28	18	34	8
	Total	25360	118	192	87	78	26
	Average	**6340**	**30**	**48**	**22**	**19**	**7**

17% of the total respondents were found to be below poverty line
(State Poverty line - Rs 457 per capita per month)

PERI-URBAN

S.No	Category	Income pm	% of income spent on food	% on carb	% on protein	% on veg	% on oil
1	Agriculture and Livestock	6667	38	36	25	23	6
2	Only Agriculture labour	6500	24	25	27	14	3
3	Only Labourer	9000	55	40	19	21	4
4	Renters with Livestock	9000	50	49	23	13	6
5	Renter without Livestock	5250	55	39	18	22	11
6	Veg Vendors	4033	44	42	26	19	8
	Total	40450	266	231	138	112	37
	Average	**6742**	**44.3**	**38.5**	**23.0**	**18.7**	**6.2**

100% above poverty line in Uppal (State Poverty line - Rs 457 per capita per month)

RURAL

S.No	Category	Income pm	% of income spent on food	% on carb	% on protein	% on veg	% on oil
1	Agriculture and Toddy tapping	3517	79	43	16	23	5
2	Agriculture and Livestock	3485	66	37	26	24	6
3	Leased land plus labour	5033	41	39	36	19	4
4	Only Labourer	3000	80	53	18	17	4
5	Only Farmer	3313	62	38	31	18	7
6	Fisherman	3692	65	47	21	19	4
	Total	22039	394	256	148	120	30
	Average	**3673**	**66**	**43**	**25**	**20**	**5**

100% above poverty line in Pillaipalli (State Poverty line - Rs 263 per capita per month)

Annex II

Musi River Water quality

	BOD (mg/l)	Total coliform (MPN)	EC (dS/m)	TN (mg/l)	Cr (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)
Urban	105	$4.6\ 10^{10}$	2.1	25	0.04	0.13	0.07	0.32
Peri-Urban	70	$2.4\ 10^{7}$	2.6	17	0.00	0.02	0.03	0.09
Rural	45	$4.0\ 10^{4}$	2.6	16	0.02	0.03	0.00	0.02

Pre-monsoon water sample May 2002

Jeroen Ensink & Uma Maheshwar Reddy