Risk Reduction
in Hubli-Dharwad, India
in Sewage Irrigated Farming Systems

High nutrient loading increases crop yields and reduces the need for fertiliser inputs, although it also results in an increased incidence of weeds and pests, with the latter controlled by habitual blanket spraying of organo-phosphate pesticides. Unregulated and continuous irrigation with sewage may lead to environmental problems such as soil sickness, soil and groundwater contamination, and phytotoxicity (Hunshal et al. 1997, Hicks and Hird 2000, Siddiqui 2000, Bradford 2001).

Furthermore, irrigating with sewage poses serious public health risks, as raw sewage is a major source of pathogens and may contain highly poisonous chemical toxins from industrial sources (Furedy et al. 1999, Zarsky and Hunter 1999). The adoption of certain micro technologies can reduce the risks faced by farmers who have irrigated with sewage.

SEWAGE FILTRATION AND IRRIGATION
Regardless of the cropping systems used the sewage irrigation method utilised along the Dharwad and Hubli sewage nal-lahs remains the same in that it consists of an overland flow and furrow irrigation system. Along both the Dharwad and Hubli transects, farmers use a ridge and furrow system to prevent the waterlogging of crops. However, the use of ridge and furrow irrigation, rather than flood irrigation, does not reduce the risk of crop contamination or reduce farmer exposure to sewage. The results of an exploratory crop test at the University of Agricultural Sciences, Dharwad, showed that crop samples taken from a ridge were still contaminated by the sewage flowing in the furrow. In addition, farmers stand in the flowing sewage in the furrow rather than damaging the ridges during transplanting and weeding operations, thus increasing their contact and exposure to raw sewage. During the dry season, vegetable crops are irrigated every two days and tree crops every ten days.

Although all farmers have adopted a common irrigation method, one aspect, which remains heterogeneous, is that of sewage filtration. Most farmers have adopted some method of filtering the sewage as it is pumped from the Nallah. The filtration serves two purposes: it prevents debris entering the pump thereby reducing wear and tear, and it prevents the fouling of soils with any debris and solid wastes present in the sewage. The various forms of filtration include: improvised gauze filters round the inlet; inlet pipe positioned inside pierced plastic barrels that act as large sieves; sieve baskets woven from natural fibres; and on one farm in Maradagi the use of a settling tank, which also serves as a sewage storage tank to ensure a sufficient irrigation supply when the sewage flow is low. If filtration is not used, any solid waste flowing in the sewage that can pass through the inlet is pumped onto the fields. As the sewage infiltrates into the soil the solids remain on the surface, clogging the topsoil with plastics and other debris. After tilling operations, the waste becomes half buried, resulting in potentially hazardous conditions for farmers.

VEGETABLE PRODUCTION
A distinct feature of the intensive vegetable production systems is
Some informal farmer to farmer networks already contribute to the process.

The increased incidence of pests associated with sewage-irrigated vegetable production systems results from a combination of factors. The planting of vegetable crops in monoculture blocks increases their susceptibility to pests. In addition, the warm climate provides opportunistic breeding conditions for crop pests and the continuous growth of crops during the dry season ensures that at a time when land is normally barren and arid, substantial green plant mass is available which allows insect populations to thrive when they would normally encounter a seasonal decline. *Plutella xylostella* (diamondback moth, DBM) and *Helicoverpa armigera* are two such pests that thrive on sewage-irrigated crops. DBM affects aubergine and most Brassica species, while *Helicoverpa armigera* infests most vegetable crops. During interviews, farmers on both sewage-irrigated farmers, on both sewage nallahs identified *Helicoverpa armigera* as a major pest currently affecting aubergine, chilli, okra, onion and tomato crops. Furthermore, Alagawadi (2001) has raised a further concern suggesting that boring pests (e.g. *Helicoverpa armigera*) that invade crop fruits (e.g. aubergine) on sewage-irrigated fields are likely to increase bacterial contamination of the crop by providing additional entry routes.

The increase in pest incidence has more implications for farmers and the environment than the increase in weed incidence. The effects of the “pesticide treadmill” combined with the continuous cultivation of crops in climates favourable to pests and where generations may exceed 14 per year has resulted in pests becoming practically resistant to all insecticides. The prolific multiplication of pests such as DBM and *Helicoverpa armigera* has resulted in crop failures and high economic losses, with the outcome in Madhihal of farmers no longer growing certain crops (e.g. cabbage) due to the lack of an effective pest control. Furthermore, despite the failure of organo-phosphates pesticides to provide effective crop protection, farmers have responded by increasing the frequency of pesticide application; weekly spraying is now a regular occurrence with some farmers spraying twice weekly. Farmers also mix pesticides prior to spraying, potentially hazardous remedies advocated by the pesticide dealers who remain the main source of extension information to peri-urban farmers. The net result is an increased risk of crop contamination and of farmers being exposed to pesticide poisoning.

**INTEGRATED PEST MANAGEMENT (IPM)**

An IPM trial was conducted in sewage-irrigated vegetable cropping systems using the bacterium *Bacillus thuringiensis* (Bt) and light traps over two seasons. While there was some crop loss due to delayed treatments, the results proved an overall success. In terms of extension success and the uptake of technologies the research work had mixed results (bearing in mind that the trial was research rather than extension-based). Once the trial was concluded, the farmer who had participated stopped using Bt spray and reverted back to applying chemical pesticides. The farmer’s decision to revert back may have resulted from a lack of confidence to continue using biological pesticides without the regular attendance of the researcher and the fact that Bt is not widely retailed and hence inconvenient to purchase. Conversely, farmers at Madihal have been keen to duplicate the light traps used in the trial and now use light bulbs (to attract moths at night) underneath which are located tubs of kerosene, which kills any moths that land in the fuel (Bradford 2001).

**CONCLUSIONS AND POLICY IMPLICATIONS**

The risks and dangers from irrigating with sewage are well documented, and in much of this literature, sewage treatment is often advocated to mitigate the public health and environmental risks (see Allison et al. 1998, Birley and Lock 1999, Furedy et al. 1999, Blumenthal et al. 2001, and Gueye et al. 2001). However, since the Hubli-Dharwad Municipal Corporation has failed in its legal requirement to treat the sewage discharged from the city region and are unlikely to implement such a programme in the near future on the grounds of high costs, farmers using sewage should be encouraged and supported to adopt safer and more sustainable farming practices. The farmers along the sewage nallahs have clearly demonstrated a readiness to adopt alternative pest control strategies with some informal farmer-to-farmer networks already contributing to that process. However, the change from the current reliance on chemical pesticides to IPM strategies will require long-term support through participatory approaches such as the use of farmer field schools that empower farmers through education and training. The development of micro technologies at the farm level to reduce risk is crucial in reducing the pest risk, and examples are clearly evident in Hubli-Dharwad, where some innovative farmers have diversified their agro-ecosystems by incorporating agroforestry practices.