CHAPTER- V
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SUMMARY AND CONCLUSION

Waste water utilization or reuse is a very old practice and has been used as a source of irrigation water and plant nutrients. Domestic and industrial waste water is disposed off on lands and used as a source of irrigation either due to non-availability of fresh water or with the assumption that the sewage effluent water, rich in organic matter and nutrients would improve or restore soil fertility. Raw sewage water may contain N, P, K, micro-nutrients (Zn, Cu, Fe, Mn) and metals (Cr, Pb, Ni, Cd) in appreciable quantities depending upon their source. However, sewage water contains very small amount of micro-nutrients and metals but their long-term use (>25-30 years) may result in their accumulation in soil and may cause pollution in soil located in the vicinity of disposal site.

Around urban and semi-urban areas of the town vegetable farming is being practiced by farmers of low socio-economic status, having small or marginal land holdings. These farmers prefer vegetable cultivation throughout the year and as much as four different crops are produced and marketed in a year, because waste water for irrigation is readily available free of cost. These farming practices however, are done in crude and irrational manner. Among vegetables, spinach, Lal Bhaji, radish, brinjal, tomato, gourd, okra, coriander leaves, cauliflower etc. are being cultivated. Farmers having large area also cultivate paddy besides vegetables. These vegetables are being cultivated in soils polluted with Zn, Cu, Fe, Mn, Pb, Cr, Ni and Cd etc by the use of
untreated raw municipal liquid waste water carrying solid (sludge) and liquid (sewage) components.

Essential nutrients and trace metals take part in redox reactions and in metabolic functions. Some heavy metals are poisonous and some are highly toxic. These metals are of persistent and bio-accumulative nature and do not break down in the environment easily. The metals being inherent component of uncontaminated soil varying from place to place are limited in amount. The essential trace metals needed by plants and subsequently by human and animals are obtained from soil. The fate of metals would be different in an ideal soil from that which is amended with waste. The concentration of these metals are reported to be 2-7 fold higher in soils receiving sewage water as compared to the soil which do not receive sewage irrigation. Irrigation with sewage waste water causes enrichment of metals in soil and may lead to increased uptake by crops grown therein.

To study accumulation of nutrients and metals in soil and plants, surface and profile soil samples and mature crop samples from the sewage affected and sewage unaffected sites were collected. Similarly, samples of sewage and tube well water were also collected. Soil, water and plant samples were analyzed for major & micronutrients as well as metals adopting standard methods and procedure.

The pH, EC and SAR were found within limits with slightly high amount of HCO$_3^-$, Ca$^{2+}$, SO$_4^{2-}$, P, N and the contents of Zn, Cu, Mn, Fe and Cr were within safe limits in sewage water but Ni, Cd, and Pb were not detected in
the sewage water. The values of all the above parameters showed that the sewage water was suitable for irrigation purpose.

The N and P content of the soil affected with sewage water was found to be significantly high and the K content were also found high as compared to unaffected soil but was not significant. The DTPA extractable Zn, Cu, Mn, and Fe was found accumulated in the surface (0-15) cm of sewage affected soil and decreased with increase in soil depth. Among heavy metals Cr and Pb were found to accumulate in the surface layer. The soils where vegetables were being produced was found to show more accumulation of micro-nutrients and metals as against those soils where paddy was being grown using sewage irrigation as compared to soil with no sewage irrigation. In sewage affected vegetable and paddy soils Fe was found to accumulate most followed by Mn. The paddy soils showed more Zn than Cu whereas vegetable soils showed more Cu than Zn. High contents of Cr and Pb were also found in sewage affected soils whereas the control soils showed absence of Pb only.

Crop species behaved differently in accumulating metals in their tissue. Concentration of metal in plant tissue and quantity of plant consumed as food determines the level in human body and resulting health risks. Metals present in high amount in soil may be readily available to crops grown on these soils. These contaminations may modify the nutritional value of food crops and consequently their suitability for human consumption. Spinach and Lal Bhaji was found to accumulate more N and K as compared to P followed by tomato, brinjal, okra and rice. The P contents were found high in okra followed by brinjal, spinach, labhaji, tomato and rice. Rice showed to accumulate least of N,
P and K. The metal namely Pb, Cd and Ni remained undetected in the crops. The rice straw registered high contents of Zn, Cu, Mn and Fe except Cr which was found to be more in rice grains than straw.

Zinc was absorbed in high amounts by Lal Bhaji followed by spinach and least by brinjal. Significantly Cu was found high in brinjal followed by okra, spinach and least in rice grain. Highest Fe was found in spinach followed by Lal Bhaji and lowest in rice grain. Spinach accumulated maximum amount of Mn followed by Lal Bhaji and least by okra. Lal Bhaji accumulated maximum Cr followed by spinach, rice and minimum was accumulated by brinjal.

Irrigating soil with untreated sewage waste water cause enrichment of metals in the soil and led to increased uptake of Zn, Cu, Fe, Mn and Cr by leafy vegetables (spinach, Lal Bhaji) as well as fruit vegetables viz tomato, okra and brinjal. Crops like rice showed comparatively least uptake of these metals. In most cases the concentration of these metals were found to exceed the safe limit.