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urban world is likely to face a massive waste disposal problem in the coming years. Until now, the problem of waste has been seen as one of cleaning and disposing as rubbish. But a closer look at the current and future scenario reveals that waste needs to be treated holistically, recognizing its natural resource roots as well as health impacts. Consequently, the demand with respect to the standard methods for the analysis of contaminants, pollutants and toxicants is continuously increasing.

Waste can be wealth, which has tremendous potential not only for generating livelihoods for the urban poor but can also enrich the earth through composting and recycling rather than spreading pollution. Increasing urban migration and a high density of population will make waste management a difficult issue to handle in the near future. So, a new paradigm for its approaching has to be created.

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I.1. The Environment

The environment is an interlocking system and operates in a state of dynamic equilibrium. Material and energy flow perpetually, regenerate and maintain an environment suitable for life. Cyclic transport of nitrogen, carbon, oxygen and other elements provide the basics of life. These elements pass from inorganic form to organic living form and back again to the inorganic. When their natural pathways are disturbed by man or other natural causes, life patterns get disrupted either momentarily or permanently. Consequently, the local species of life may get destroyed. It is in this delicate balance of nature, the field of Environment Management emerges.

Environmental Management is an important discipline. It is no more an empirical set of procedures and guidelines. The discipline of environmental management has three dimensions: first, it takes into consideration and attempts to prove management which will maintain a reasonably close to the natural balance for this system; second, it reflects on the best attainable long term conditions for human society, including its socio-economic aspects; third, it determines the solutions which are technically and economically feasible for a sustainable development.

The sustainability of human development is based on the sustainability of the energy systems that are introduced and exploited. All developments within the context of the agro-industries systems are based on the use of appropriate and cost-effective supplies of energy [1].

I.2. Waste Management

Waste management is a discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid and liquid wastes in a manner that is in accordance with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations and that also is responsive to public attitudes. In its scope, solid and liquid waste management include all administrative, financial, legal, planning and engineering functions involved in the whole spectrum of solutions to problems of solid wastes thrust upon the community by its inhabitants. The solutions may involve complex interdisciplinary relationships among such fields as political science, city
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and regional planning, geography, economics, public health, sociology, demography, communications and conservation, as well as engineering and materials science.

Industrial growth is essential for the economic development of a country and at the same time protection of our environmental system is necessary for the biodiversity to continue. An integration of the environment and development is required at the policy planning and management levels. For integration at the policy levels, what we need to have is system analysis and system models of our environmental system for management.

A system is structured set of objects or characteristics or both and management is a decision-making process. Environmental system is a process-response system that is continually being degraded by an ever-expanding, fuel powdered, urban - industrial society.

Waste management is the process by which workable alternative programs and plans are developed to solve solid and liquid waste problems. In most situations the alternative programs and plans must be presented to the public and to decision-makers for consideration, selection and adoption.

1.2.1. Functional elements

The functional elements of waste management are: waste generation, storage, collection, transfer and transport, processing and recovery and disposal. The functional element represents a physical activity. By considering each functional element separately, it is possible, first to identify the fundamental aspects and relationships involved in each element and second to develop, where possible, quantifiable relationships for the purposes of making engineering comparisons, analyses and evaluations. The separation of functional elements is important because it allows the development of a frame work within which to evaluate the impact of proposed changes and future technological advancements [2].

Waste materials (gas, liquid and or solid) arising from human and animal activities are discarded as useless or unwanted. The term as used in this context is all inclusive and it encompasses the heterogeneous mass of throwaways from the urban community as well as the more homogeneous accumulations of agricultural, industrial and mineral wastes. The classification of wastes is as shown in Fig I. 3.
Fig. I.1. Simple diagram showing the interrelationship of functional elements in a solid waste management system.
Fig. 1.2. Material flow and the generation of solid waste in a technological society
Solid Waste

Domestic waste

Commercial waste

Industrial waste

Miscellaneous

Agricultural waste

Crop residues

Paddy

Wheat

Millet

Maize

Agro-industrial residues

Turmeric

Pepper

Fennel

Cumin

Fig.1.3. Classification of solid waste
1.2.2. Agro-industry waste management

One of the challenges that agriculture and food industry face is in handling wastes. When it comes to disposing of these wastes, it turns out to be a big burden. Considerable opportunities exist for the profitable recycling, processing and re-use of agricultural and agro-industrial wastes. Activities which reduce the levels of waste, enhance opportunities for waste recycling and reuse and promote novel uses for waste is one of the thrust areas of research and commercialization. In a biobased economy, there are three elements: economic, environmental and social. A biobased economy mimics the natural ecosystem. Thus, there’s no such thing as waste, the waste of one organism is another’s useful source. Reuse and evaluation are areas which can find a solution to the thousands of tons of organic residues generated every year by the agrifood industry.

Biomass can be used as an energy source in its solid form, and it can also be converted into a liquid or gaseous state. The process is very similar to the conversion of fossil fuels, such as coal, into a viable energy source. Most of the time, the biomass is burned, and the heat is converted to electricity with a steam or gas turbine, or an internal combustion engine [3,4].

The use of waste streams to produce cellulosic ethanol can be an environmentally friendly and cost effective process. One of the most economically efficient ways of producing it is through the use of agricultural wastes such as industrial “residues,” or byproducts of food, fiber and forest production. In essence, waste streams can instead become revenue streams — a “win-win” strategy.

1.2.2.1. Potential availability of agro-industrial residues

Agricultural residues can be divided into two groups: crop residues and agro-industrial residues. Crop residues are plant materials left behind in the farm after removal of the main crop produce. The remaining materials could be of different sizes, shapes, forms and densities like straw, stalks, sticks, leaves, haulms, fibrous materials, roots, branches and twigs. The agro-industrial residues are by-products of the post-harvest processes of crops such as cleaning, threshing, linting, sieving, and crushing. These could be in the form of husk, dust, straws etc. The major crop residues produced in India are straws of paddy, wheat, millet, sorghum, pulses,
oilseed crops, maize stalks and cobs, cotton stalks, jute sticks, sugar cane trash, mustard stalks etc. The agro-industrial residues are groundnut shells, rice husk, bagasse, cotton waste, coconut shell and coir pith. For the last few decades the emergence of nutraceutical industry are producing considerable amount of agro-industrial residues which needs immediate attention of environmental technologists [5].

The quantity of agricultural residues produced differs from crop to crop and is affected by seasons, soil types and irrigation conditions. Production of agricultural residues is directly related to the corresponding crop production and ratio between the main crop produce and the residues, which varies from crop to crop and, at times, with the variety of the seeds in one crop itself. Thus, for known amounts of crop production, it may be possible to estimate the amounts of agricultural residues produced using the residue to crop ratio. It may be noted that with improved agricultural farming techniques, the production of crops has been increasing consistently in the past three decades. Correspondingly, the availability of agricultural residues has also been changing with time.

I.2.2.2. The environmental impacts of the food sector

The principle of waste prevention is universally accepted, the practice has lagged far behind. Food industry will also have to concentrate on waste avoidance as well as utilization of process wastes. Application of clean technologies enhances the safety and quality of the product as well as reducing the energy requirements and environmental impact of the industry. The main environmental impacts of the food sector are aquatic, atmospheric and solid waste emissions. By choosing proper separation technology, wastewater treatment is usually carried out and is implemented in process installations. The atmospheric emissions are mainly caused by extensive energy use. The food industry to agro-industry consumes a great deal of energy for heating buildings, processes and process water, for refrigeration and for the transportation of raw materials and products. The increased share of renewable energy sources could slowly reduce the amount of conventional fossil fuel utilization [6].
Solid by-products and wastes are also generated in high amounts in the food industry. The main treatment method of solid wastes is, at present composting. Recovery and re-use of by-products and wastes as raw materials is another option. However, microbiological quality and safety is always of major concern.

Agriculture is an important part of the economy. Besides, the crop itself, large quantity of residues is generated every year. Rice, wheat, sugar cane, maize (corn), soybean and ground nuts are just a few examples of crops that generate considerable amounts of residues. These residues constitute a major part of the total annual production of biomass residues and are an important source of energy both for domestic as well as industrial purposes [7].

Biomass energy is an important source of energy in most Asian countries. Substantial amounts of fuel wood, charcoal and other biomass energy such as agricultural residues, dung and leaves are used by households and industries. The main household applications are cooking and heating whereas industrial applications range from mineral processing (bricks, lime, tiles and ceramics), food and agro processing, metal processing, text tiles (dying, etc) to miscellaneous applications like road tarring, tyre retarding, and ceremonies. Beside, these ‘heating’ applications, biomass fuels are also used for power generations, for example the widespread use of bagasse in sugar industry (steel and electricity) and oil palm residues (steel and electricity) [8]. A lot of biomass fuels are available as byproduct from other activities, such as saw milling and agricultural crop production.

1.2.2.3. Agro-industrial residues

Agro-Industrial residues are waste for many purposes and such uses often are site specific. Besides, being used as fuel, which can be considered as being one of the “6 F’s”, residues are also used as Fodder, Fertilizer, Fiber, Feed stock and Further uses. The latter “F” comprises for instant residues being used as a soil conditioner (example; coconut coir, dust used to retain moisture in the soil, straw as growing medium for mushroom, coconut husks as a growing medium for orchids, packing material). In some case residues may even have a multipurpose use. Rice husk can be burned as fuel with ash being used by the steel industry as a source of carbon and as insulator (Feed stock, Further). Rice straw can be used as animal bedding (Fiber,
Further) and subsequently as part of compost (Fertilizer), crop waste can be used as feed stock for biogas generation (Fuel), with sludge being used as fertilizer. Never the less the biomass produced by some cash crops like turmeric, pepper, fennel to mention a few do not show encouraging property as a fuel due to their structures. Alternatively, they can be used as a source for the recovery of important nutrients. Thus, there is a need to develop new techniques and methods to reuse and regenerate the usefulness of nutraceutical industry residue.

1.3. Environmental Analytical Chemistry — An overview

Environmental Analytical Chemistry as a discipline has played a major role in facing the challenges taking place in the Environmental Management. Traditionally viewed as a service organization, of late the Analytical Department has become a significant partner taking a major role in Environmental Monitoring. Indeed, the demand for analytical data has become very critical for the evaluation of environmental data. Working under stringent environmental laws and consumer awareness, the environmental analysts are called on to generate accurate and precise data - almost on demand. The science and technology utilized today, coupled with the new environmental regulations that are now binding, have made environmental analyses much more complicated compared to what it was about ten years ago.

In recent times, modern environmental analytical chemistry entails much more than mere analysis of active components in the environment. There are many reasons for this change, not the least of which is our ability to understand better the physicochemical properties of environmental pollutants through the use of advanced instrumental technology.

Analytical data is the basic need and backbone for environmental monitoring. Simple and cost-effective analytical methodologies, techniques, methods and protocols are very much desirable for effective implementation of environmental management.

Analysis of contaminants and pollutants involves both identification and quantitation of components in simple or complex environmental matrices. Instrumental methods are generally resorted too. Nevertheless, spectrophotometric and chromatographic methods take precedence over other methods. Between these
two types of methods of analysis, spectrophotometry has the advantage for three reasons: simplicity, sensitivity and low cost of the instruments.

Spectrophotometric methods are among the most precise instrumental methods of analysis. Furthermore, the basic apparatus required is spectrophotometer, now fairly cheap and certainly much cheaper than most other instruments used in analysis. The resurgence of spectrophotometry depends heavily on many heterocycles which will help for the development of sensitive and selective methods in the newly discovered field of environmental analytical chemistry. Further more, spectrophotometry is regarded as one of the classical methods in environmental analysis. And its importance has not decreased to any extent even during modern times. Moreover, as a result of coupling with other methods its field of application has widened and its importance continues to increase [9-10].

Spectrophotometric methods are remarkable for their versatility, sensitivity, and precision. Almost all are direct and can be used for most toxicants, organic compounds including carcinogens. A very extensive range of concentrations may be covered, from macro quantities (especially by the differential method) to traces (10.6-10.8 %) (After preconcentration) depending on the molar absorptivity.

1.3.1. Spectrophotometry ... ... ... ... the basics

Spectrophotometric methods for the determination of substrates are based on the absorption of visible and near ultraviolet radiation. Formerly, visible spectrophotometry was often called colorimetry and even now such definitions as colorimetric, photometric or absorptiometric methods are sometimes used in the literature, as equivalents to the term spectrophotometric method.

The basis of visible spectrophotometric methods is the simple relationship between the absorption of radiation by a solution and the concentration of colored species in the solution. The color of the determined itself is utilized much less often. When the determined is not colored, or forms no colored compounds, indirect spectrophotometric methods may be used for its determination, or ultraviolet spectrophotometry may be used if the determined, shows appreciable absorbance in the UV region [11-16].
1.3.2. Spectrophotometry... ... ... *the supplementary technique.*

UV-visible spectrophotometry has considerable importance as one of the spectroscopic methods supporting in environmental research. In certain cases, the spectra provide valuable information of primary importance which helps in structure elucidation studies. The presentation of UV-visible spectra or the wavelengths of their maxima and minima, are important means for identification of environmental toxicants.

The determination of absorbance spectra of environmental toxicants provides information with a similar value as the measurement of other physical constants. In majority of cases these spectra indicate only the presence of certain functional groups and structural elements rather than giving information about the molecule as a whole. In this respect spectrophotometry can be regarded as only a supplementary method to infrared, mass and NMR spectroscopy, which are definitely more effective tools for the structural elucidation of environmental pollutants.

Quantitative analytical application is of prime importance in the use of UV-visible spectroscopy in environmental toxicant analysis. Methods based on natural absorption of toxicants and absorption of light measured after chemical reactions are extensively applied for the determination of toxicants in environment. Selectivity - a casualty in the field of spectroscopy can be enhanced by the application of various derivative and different spectrophotometric techniques, as well as of mathematical methods for the investigation of multi component systems and for the solution of spectral background problems. A similar situation exists in relation to the application of spectrophotometric method in the quantitative analysis of environmental matrices [17-20].

The importance of spectrophotometry in the field of environmental analysis has further greatly enhanced, because of the fact that this method is readily amenable for automation. Automatic analyzers equipped with spectrophotometric detectors have come up for the serial analysis of soil, water and air samples.
I.4. Summary

Agro-industries is a predominant sector of world’s economy and has reached a plateau through the use of external input-intensive technologies. These technologies helped to increase demand of feed, food and functional foods for teeming billions, but, such technologies are resource degrading and environmental polluting. In such a situation, agricultural production cannot sustain for an everlasting period. Thus, for sustainable agricultural development there is an urgent need for an effective management of agricultural waste. Reuse, regeneration and recovery are the three components of recycling—one of the important curative approaches in environmental management.

Today, pollution control boards and agencies are under increased scrutiny from the government and public interest groups to provide reliable data of environmental toxicants to implement effective environmental management methods. Consequently, the demand with respect to the standard methods for the analysis of contaminants, pollutants and toxicants is continuously increasing. The present trend is to enhance the selectivity and increase the sensitivity of the determination. As a consequence of these increasing demands, spectrophotometric methods are now being focused on chemical reactions which may improve the selectivity and sensitivity of the method. The present research studies are an effort in this direction.
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References

5. Sanjay Mande, Biomass gasifier-based power plants, The Energy and Resource Institutue, New Delhi, India.
Objectives of the thesis

- An attempt to shift the university research from functional academics to need-based-academics.

- To give value-addition to the agricultural waste and an attempt to transform waste to wealth.

- To evaluate the usefulness of agro-industrial waste.

- To develop simple and cost-effective methods to recover important nutrients from agro-industry residues.

- To study antioxidant activity of the extracts through in vitro models such as free radical scavenging activity using 2,2-diphenyl-1-pycrylhydrazyl (DPPH) method, β-carotene-linoleate model system and iron(III) reduction method.

- To study the antimicrobial activity of the extracts by pours plate method.

- To study the application of extracted phytochemicals for its antioxidant property in refined sunflower oil.

- To develop newer and easy-to-use spectrophotometric methods for the determination of certain toxic metals and non metals in environmental samples and biological samples.