Bio solid & liquid wastes management using Biosanitiser based stabilisation process and methanation

Holistic approach

It is that approach should be holistic and not compartmentalised. The summation of benefits is greater than the individual benefits of its parts. For example **why has organic farming not taken off**? Some people say there is not enough manure of the right quality to spread in the vast agricultural fields. On the other hand there are scientific studies, which go to show that nitrification of soils has increased manifold in the last century. Even leguminous crops and natural manures are not exempted since they add to nitrogen in the soils, creating excess. There is also talk of Carbon: nitrogen ratio and organic carbon content in tropical soils are less due to the torrential downpour of monsoon rains causing run off of minerals and faster decomposition of vegetative mater and mineralisation of the compost.

Bob Dylan sang "The answer my friend, is blowing in the wind". The Japanese guru of Organic farming Mr Masanobu Fukuoka said imitate nature and he based his observations on the Buddhist teachings. Every religion has taught organic farming principles to its followers. The closer you imitate nature and take work out of its own complexity, the less exhaustion to its apparently endless ability to refurbish itself. Shortcuts like chemicalisation, dumping of wastes into landfills, river streams and oceans have clearly not yielded results.

Why do we not find employment opportunities in rural India? Making organic manures will provide jobs to millions. Again organic farming should not be taken up on a stand-alone approach. People buy land and want to practice organic farming. There is no inherent economy in resources mobilisation and utilisation, if practiced as a fad rather than as a business opportunity. **Hence the vast majority of poor farmers who depend upon rain fed farming can be helped if the whole nation changes its mindset on how it manages its natural resources, economises use of energy and overall prepares a balance sheet on how it has performed over a period of time. There should be no externalised costs to development and everything should be taken care of in a totality of cycles. What is externalised out of various cycles be they carbon, oxygen, air, water is often termed as waste and seen as a problem. In reality they are not and the solution to the problem lies in bringing such externalisations back into the endless stream of cycles.**

One such cycle is the waste management and return of nutrients back into the soil. When we return the composted humus back to the soil, we are at least partially imitating nature such as in a tropical forest, which is really perfect in management of resources. Humans are essentially parasites, who take from nature but now need to learn on how to give back to the host. So the civilisations built upon such take only approach are the cause of the blight. We should harmonise our relationship of inevitable dependence upon nature, rather than trying to control it, in order to suit our short term interests alone. Excessive dependence upon intellect and technologies and its misapplications are the root causes of the problems. Do we then go back to an era when we did not have those? An era when it was pre industrialisation, pre mechanisation of agriculture?

It need not be so. We can use science and technology to find answers at the root cause and not cosmetic levels. Discrimination at various decision-making levels on how science and technologies should be used is also called for. In the following seven pages, the attempt is being made to apply holistic approach to problem solving and hopefully this can yield results. It can and indeed should, if we apply the concepts holistically rather than in a piece meal fashion.

This approach will also find a wider appeal to all stakeholders in development. Organic farming enthusiasts who normally shun city waste sludge composts due to high levels of toxic matter, will welcome the availability of good quality humus, free of pathogens and of safe Ph levels. Similarly, chemical farming enthusiasts, can welcome the high quality compost being made available at economical prices, to enable return on investments in the sort term too. They should also welcome it in the long run when they find that it improves soil quality not so much by its NPK and other constituents but by the ability to hold water, consistently help raise healthy plants which experience lesser pest problems due to greater availability of all nutrients including micronutrients. Dr Uday Bhawalkar's bio sanitizer is used to treat the waste problem, and also use it profitably in agriculture. Experiments have been conducted and quite successfully too that one can raise healthy plants right on a compost bed with very little soil, based on addition of the daily kitchen wastes, if the bio sanitizer is applied in right proportions.

Dr Bhawalkar himself is a proponent of the theory of excessive nitrates, which is confirmed by independent studies on presence of nitrogen. He advocates direct application of wastes into fields like a mulching practice. The difference in my approach is that I advocate production of methane as a clean energy source as an intermediate step, when fermentation is easily manageable. Homogenous substrates like animal and human excreta allow this.

Waste to clean renewable energy and soil nutrients

Step 1: Hazardous waste disposal

At the average household, we generate several type of wastes – organic, plastic, glass, metals – ferrous and non-ferrous. Organic refers to the kitchen wastes, left over food etc. Ferrous refers to iron and steel items. Non-ferrous refers to other metals like brass, aluminium, nickel etc. This classification is based on segregation and recovery of valuable products and recycling the materials. This practice is gaining ground worldwide and we in India can be no exception.

There is one more type of waste – hazardous wastes-organic and inorganic chemicals, heavy metals etc. To this may be added items like used engine oils. These wastes are mentioned here since an average household generates wastes, which are recyclable and some wastes which are however of a hazardous nature – chemicals and other substances as mentioned above. Some examples are: used dry cell batteries, button cell batteries, Nickel-Cadmium batteries, broken tube light glass shells, which contain a toxic chemical. In U.S.A. for example NiCad batteries have to be returned after it becomes useless, to a facility for recycling/disposal. It cannot be dumped into the municipal waste bins. One U.S. company specialises only in recycle of fused tube lights!

Normally we tend to dump it into our wastebasket and this goes to the city municipal dump. The city municipality normally dumps wastes into landfills or generates manure, particularly out of organic wastes, after other wastes are removed from it. If we segregate the wastes, then the task becomes easier at the final stage. The hazardous wastes, if dumped into landfills or go untreated into the manure, will pollute the soil, and the ground water. We have to remember that we are getting more and more ground water for our daily needs and we cannot poison ourselves.

Hence it is suggested that each locality keeps several drums in the colony with a lable in Hindi / local/regional language and English – "Only for Hazardous wastes, please do not dump organic, plastic, glass wastes into this bin". The residents of this locality/ colony may be requested to dump articles like used dry cell and Ni-Cad batteries, acids, any left over organic and inorganic chemicals, expired drugs and medicines, broken tube light glass shells, heavy metal objects made of lead, mercury (from broken thermo meters).

I put a plastic bag and started collecting such wastes, instead of dumping it as usual into the waste bin. In just a few months, a sizable collection of used batteries, used tube light shells was generated at my household. If we assume that on an average, there are 200 flats/households in a locality / colony, we can conclude that 200 times this waste is being generated in one colony alone.
– R. Santhanam

Once the drums are full, the Municipal Corporation should take away and dispose off the hazardous wastes, separately as per approved procedures. Currently this is simply not being done! These toxics get into colas and drinking water.

Step 2: Bio methanation technology

The second most promising and immediately available source of clean energy from renewable sources however, is CH_4, which is also known by different names – methane gas, gobar gas, natural gas, and producer gas. The best source of such energy is biomass – the substrate made of carbohydrates manufactured in the photosynthesis process in plants. In the anaerobic fermentation process, such as in the well-known gobar gas, bacteria decompose the substrate in a digester, without the presence of oxygen. The resultant gas is the biogas, mostly methane (CH_4). The typical composition of the resultant gases will vary. Mostly it is about 60-70% CH_4, Carbon dioxide (CO_2), and some water vapour. If municipal wastes are used as a substrate, usually Hydrogen Sulphide gas (H_2S) is also released. Technologies are available for scrubbing the biogas to reduce the level of CO_2, and remove or reduce water vapour and Hydrogen Sulphide (H_2S). If biogas is used for energy, then it makes sense to improve its calorific value.

The scrubbing of the biogas usually results in concentration of methane (CH_4) to about 80%. One of the options is to **cultivate algae like Spirulina Blue green algae** which is a rich source of beta carotene. The algae grows in a brackish water medium and the tank is closed at the top with a glass top to allow sunlight. The bio gas is bubbled up through the tank and CO_2 gets absorbed in the algae photo synthesis, resulting in an improved calorific value with higher concentration of CH_4. Hence the useful by product spirulina can be cultivated on a large scale, which can help bridge the per capita protein deficiency in India. This cultivation improves photosynthesis due to CO_2 absorption and hence algae yield is better for same unit area.

Removal of H_2S is necessary because when burned in an engine it causes formation of Sulphur dioxide and ultimately sulphuric acid, which corrodes and reduces the life of the engines. Maybe this sulphur can be added back into the last stage of vermi compost since sulphur is a deficient micro nutrient item in many agricultural systems, after world-wide preference to low sulphur crude leading in turn to less "acid rain" – there are some research papers on this, particularly in Europe.

Biomethanation of human and animal wastes: The underlying principle in the process is anaerobic digestion. It is a method of conversion of organic fraction of animal and human excreta to mixture of gases, containing about 60% Methane CH_4 and 40% Carbon dioxide (CO_2) and small quantities of Ammonia (NH_3) and Hydrogen Sulphide (H_2S) and has a calorific value of 5000 K Cal/M_3.

This methane gas can be used for:

(1) Cooking and heating in cities and is normally transported by a pipe system.

(2) Generating power or electricity through micro turbine, diesel /gas /dual fuel engines. However its is advisable to scrub the gas to remove H_2S and NH_3 when it is used in any type of internal combustion engine. When the gas is clean, it can be used in transportation also such as city bus and automobiles. Compression is the only problem.

The residual mass left over can be used as manure. This manure derived out of Methane preparation which is also called as biogas manure, is very useful for soil/crops. The solid residuals can also be treated with Biosanitiser for better stabilisation of pathogens and also retard mineralisation.

Concerted effort is required to explore scientifically and commercially the renewable sources of methane gas production, particularly animal and human wastes of excreta. Since these substrates are uniform, they are better amenable for fermentation with type specific microbial cultures, ensuring consistent gas production. **MSW is not suitable for direct fermentation for methane gas production due to their non-uniform nature, being a mixture of assorted organic bio solids. Hence it is difficult to standardise and ensure consistent fermentation on such substrates.**

The benefits of methane gas as renewable energy source are enormous – It will cut down on the foreign exchange drain on India's import of crude oil, which will be largely replaced by CH_4 produced from renewable sources. **It will reduce the emission of Carbon, since such wastes release methane gas anyway by natural aerobic fermentation, but is now made available in a controlled process and its energy is used and it replaces equivalent amount of fossil fuels which would have otherwise been burnt. This means a reduction in levels of carbon emissions as Green House Gases into the atmosphere**. In today's global warming threat looming large over the world, this is an important step in bringing down carbon emissions from India. Micro turbines instead of IC engines offer better economics for generation of electricity with less MTBF and offer pay back in less than two years of the investment cost. In USA use of micro turbines is a proven technology since it reduces overall emissions particularly No_x as compared to IC engines.

In the context of global warming, CO_2 emissions are projected to grow from 5.8 billion tonnes carbon equivalent in 1990 to 7.8 billion tonnes in 2010 and 9.8 billion tonnes by 2020. Much of it is expected to come from developing world – 81% of the increase during 1990-2010 and 76% of the increase between 1990- and 2020. The developed world of course would not like to give up their energy sources –mostly from fossil fuels! They would like to bury CO_2 into the Earth! (Australia). These figures are also widely varying depending upon who is making the statement!

Small farmer with a few cattle and large farms, herds and cattle sheds can resort to methanation. Villages can go in for community digesters for human excreta streams. The available gases can be used for lighting, cooking needs of the rural inhabitants. Women will experience less drudgery for daily fuel needs, which is mostly gathered. Dr.A.D. Karve's digester uses carbohydrates like spoilt food and damaged grains

to generate comparative larger volumes of methane as compared to digesters using excreta as the substrate. This innovation is a welcome development as it enables wastes to be put to good use.

Step 3: MSW Bio solids stabilisation

The driving force behind the introduction of vermiculture, composting or other such waste reuse processes, is the global recognition of the need to recover organic material and return it to the soil. Legislation is being enacted to prevent the dumping of organic material as landfill. Simultaneously, the cost of dumping organic wastes are increasing and farmers are becoming more aware of the need to change their practices to halt and reverse the degradation of their soils. There is thus market pressure for the waste processing and the consumption of the end product, enabling launch of a whole new industry, which offers sustainable development for a change!

To be a viable alternative, very large-scale vermiculture must be proven to be ecologically and commercially sustainable, capable of being operated without subsidy, on a competitive basis. Among developed countries, Australia and USA have shown that it is commercially viable to use earthworms in treatment of MSW organic waste. MSW vermicomposted has shown stabilisation for pathogens and is ph neutral and hence for most crops. However vermi composting is laborious particularly when using surface feeders like *Eisenia Foetida*, which cannot tolerate their own cast and can die. Hence when these are used, the vermicomposting pile has to be periodically cleaned of such casts. There are very few trial and experimentation using deep burrowing earthworms, since this differentiation is not widely recognized! Deep burrowing varieties of earthworms are able to eat their own cast many times, each times improving the stabilisation process.

Compost (final produce) exceeding the concentration limits stated as below, shall not be used for food crops. However it may be utilised for purposes other than growing food crops. Ministry of Environment & Forests – Municipal Solid Waste (Management & Handling) Rules under the Environment Protection Act of 1986 had made it mandatory for all municipalities to set up waste process and disposal facilities by 01.12.2003, and had also laid down standards for composition and concentration limits of MSW compost, which can be used for food crops.

Ministry of Environment & Forests vide gazette notification S.O.908 (E) dated 03.10.2000 has set guidelines and maximum permissible limits of heavy metals and impurities as per following table, which need to be followed for selling urban compost for production of food crops.

Parameter	Concentration not to exceed: (mg./kg dry basis, except p^H value and C/N ratio)
Arsenic	10.00
Cadmium	5.00
Chromium	50.00
Copper	300.00
Lead	100.00
Mercury	0.15
Nickel	50.00
Zinc	1000.00
C/N ratio	20/40
p^H	5.5-8.5

Soil nutrients – relevance to Indian agriculture

The present demand of 200 Million tonnes of Food Grain production will rise to 300Mill.T. by 2020. 57% of Indian soils are degraded with different types and degrees of problems. Soil erosion is the biggest hazard, covering 50% of the soils, followed by water logging (3.5%) and salinisation (3.1%). The degradation is more pronounced in the fields of small and marginal farmers, representing 78% of the farming community.

Recognition is necessary that what is taken out from the soil as nutrients in food, has to go back from the waste into the soil, instead of being dumped into rivers and land fills uselessly. This means that the **cities will feed the rural farms with nutrient inputs**. This will also be less energy intensive than chemical fertilisers, toxic pesticides being applied currently. This calls for **integration with our agricultural practices, where we should use more and more of organic manures**, instead of chemical fertilisers.

It is now being widely recognised by scientists that practices of applying chemical fertilisers, pesticides are not sustainable in the long run. The soil requires biodynamic activity with teeming life forms, which are continuously active and keep the soil naturally fertile and make available the necessary nutrients to crops. Application of NPK fertilisers kills this activity and introduces a non-sustainable cycle. In the long run scientists have found that increasing doses of fertilisers are required. Most of it washes away into rivers, groundwater, thereby polluting them and causing irreparable damage to the environment. Such costs are not estimated in monetary terms, but are externalised with short-term viewpoints.

Currently chemical fertilisers play no doubt an important role in ensuring India's food security. However they come at a price both to the exchequer and the ecology. Subsidies for fertilisers are more than Rupee 17,000 crores, at present in India. The developed world also subsidises its agriculture to the tune of more than U.S.$ 360 billion per annum! Instead of playing follow the (rich) leader, **India can take the lead for managing the transition to an organic agriculture.**

Application of sludge or effluent from municipal drains which has been pre treated with Biosanitiser to town municipal organic waste, which has been segregated at the time of collection prior to methanation, will yield humus, free of toxic elements including heavy metals, common to urban wastes. Biosanitiser stabilised MSW has shown a marked reduction of harmful pathogens, normally associated with MSW. It is pathogen stabilised and ph factor can also be ensured neutral by simple method of adding rock dust or horticultural wastes. This will convert the problem of MSW into a stabilised bio solid, excellent for use as manure suitable for most crops. Although experiments are going on to test the level of heavy metals toxics, earthworms /Biosanitiser can handle, segregation at the waste collection stage is a sensible approach, harmonious to nature. The stabilised bio solid is a natural rich organic soil amendment made up of humus like organic material which yields more or less balanced array of macro and micro plant nutrients, perhaps qualitatively even better than vermicompost or worm castings.

Optimal plant nutrition without side effects of excess

Such **stabilised bio solids** are an efficient source of nutrients for plants that dramatically improves the physical texture and fertility of soil. They do not add excess nitrates, phosphates like chemical fertilisers. Even the practice of cultivating crops, which fix atmospheric nitrogen to the soil, will become unnecessary. One study has determined that such leguminous cultivation in fact adds to the nitrogen content in soil to levels beyond permissible. This stabilised bio solid can thus help replace valuable nutrients taken out of the soil when food grains, fruit and vegetables are harvested. Stabilised bio solids also create the environment for beneficial organisms to appear in the soil in a natural process. **The requirement of such beneficial micro organisms is taken care of in a zero cost natural and catalytic process through Biosanitiser application on wastes and renders expensive technologies like maintaining inoculums and preparing cultures obsolete or unnecessary! Dr Uday Bhawalkar says 1 gram of Biosanitiser does the work of 1 acre of forest and is like a factory producing workers, whereas other technologies offer workers like microbial inoculums on piecemeal basis.** These micro organisms and soil fauna help break down organic materials and convert nutrients into a more available food form for plants. Adding such stabilised bio solids to the soil also aids in erosion control, promotes soil fertility, and stimulates healthy root development in plants.

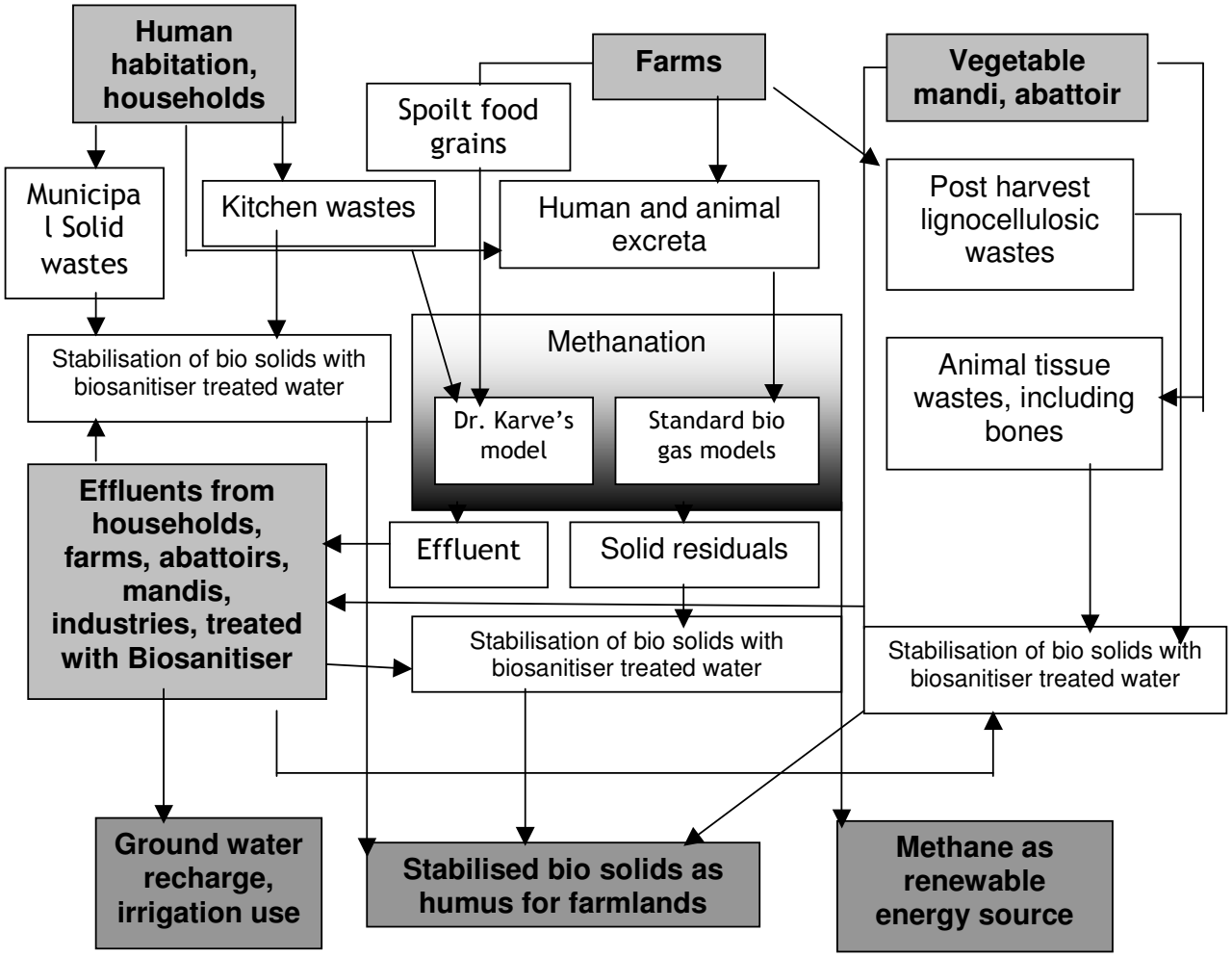
For the majority of Indian farmers cultivating poor rain fed soils, this will be good news, since they can apply the stabilised bio solids as humus free of toxic elements, thereby ensuring moisture retention and improved soil fertility. This will go a long way to improve small farm productivity in India. Organic farming movement is gaining ground world-wide and India should take the lead, and also make use of traditional knowledge base. Organically cultivated crops show improved pest resistance and require less or no pesticides. They are also cleaner foods than chemically cultivated food.

Ideally these should be set up on Build, Operate, Train And Transfer (BOTT) basis. Data should be collected on costs, economics, on pilot projects so that economic modelling and planning can be launched for replication at a national level not only in India but everywhere. If cost economics become established, then cooperative ownership of such facilities would be the ideal choice, so that local communities own these facilities and have a stake in their successful management. State ownership is an avoidable evil, community owned enterprises being a better option. Such community owned enterprises would help agglomerate production and help pave the way for marketing of organic produce in metros and export markets. They can also trade among themselves; thereby avoiding market uncertainties associated with distant export markets. Only the surplus should be sold outside such networks. This also minimises use of fossil fuels in unnecessary transportation.

Revenue streams represent avenues to make the enterprise wholly self supporting without subsidisation from the state. There may be problems – purchasing power for people below the poverty line called as BPL in India. Partial or time bound subsidies for economically weaker sections can be examined as an option till their income level goes up. Hence state subsidies can potentially work within a system like outlined above and leverage economic development to reach all sections of the society rather than the trickle down effect. Needless to say ecological imperatives are also taken care of.

Some of the perceived advantages include: reduction in green house gases emissions by using anaerobic fermentation and stabilisation instead of aerobic fermentation of wastes, production of clean renewable energy – methane from wastes, return of soil nutrients to agricultural fields, making it sustainable, addition of high quality humus to soils, reducing water consumption in agriculture, pollution abatement by isolating toxics and recyclable wastes from city wastes.

Bio solid & liquid wastes management using Biosanitiser based stabilisation process and methanation



This diagram is not complete since it will entail too much detail. For example, effluents from household, farms, abattoirs, industries (not shown) will be stabilised with biosanitiser and used for moistening various bio solid wastes as a method of treatment. Large volumes of treated effluents can be used for irrigation, ground water recharge. Industrial effluents require treatment with phototropic plants/ algae in tanks which have biosanitiser as catalysts.

One methodology which is not shown is to irrigate farmlands which have various bio solid wastes applied for *in situ* cold composting. Animal waste can also be directly applied on farmlands, which either have Vermi^{++} applied on the farmlands or use Sujala treated water, which again can be from various sources like bore wells, canal irrigation or biosanitiser treated effluents.

My earlier version of the article is posted at the Internet web site:

https://www.periurban.org/download/pub/newspaper/Santhanam_2005_Usewaste.pdf
Since I keep researching the topic, I continuously redevelop the concept and my latest version of the article is attached.

The concept notes using the Holistic approach to wastes and agriculture, was appreciated by:

- TERI, who have featured an article on their online newsletters on my views, particularly on segregation of Urban Municipal Solid Wastes. (Next page)
- Dr. M.Swaminathan, as "socially relevant" technologies,
- Green Peace Germany and Farming Solutions USA, who recommended me as one of the World Authors to the IAASTD.
- Dr. David Pimental of Cornell University, USA, who is well known for his research findings, advocating against the use of corn to make Bio fuel ethanol due to inefficiencies on energy conversion.
- Dr. Dickson Despommier, Columbia University, USA on alternative uses of Biomass wastes from cities.

Contact the author of this article: rsanthanam_delhi@yahoo.com
For supplies and technicalities of using Biosanitiser: gopal_sane@sify.com

'Steamy recipes: no raw deal'?

Research from the Scientific Research Center in Murcia, Spain, shows that steam-cooked food is the healthiest while microwave-cooked food is the least.

To come to this conclusion, the research team compared nutrients remaining in broccoli cooked in different ways. They found that microwaving destroyed almost all the anti-oxidants like flavonoids, while steaming left them almost untouched. 'Internal heating is far more damaging,' says Cristina Garcia Viguera, the team leader. Pressure cooking and boiling had intermediate effects with many anti-oxidants leaching out into the water, leaving the food with just 20%–45% of the original.

Anti-oxidants mop up the highly reactive free radicals in our body that can damage cells, increasing the risk of cancer and degenerative diseases.

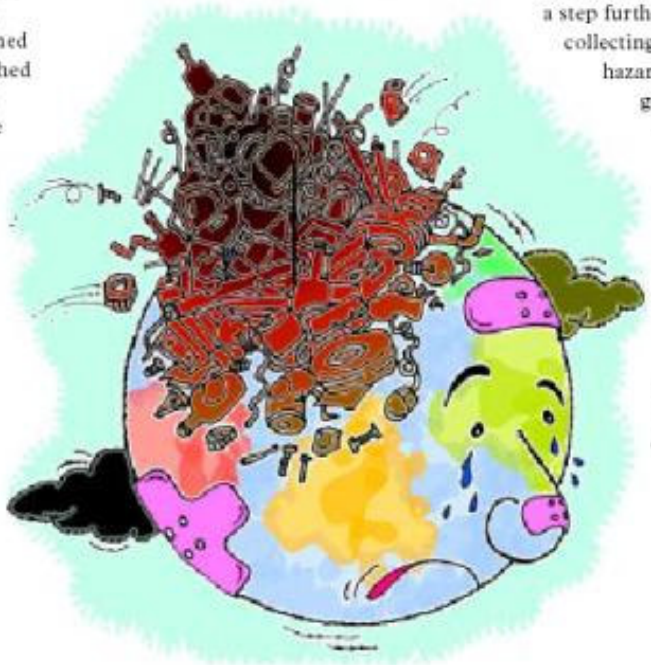
Of course, experts also say that some kind of cooking is better than no cooking, as the human body cannot absorb nutrients directly from raw food.

Source: New Scientist

Tread softly, we have but one earth...

Here is an interesting observation that a concerned and enlightened reader of *TerraGreen* wished to share. How does one dispose hazardous waste generated at home?

The idea may sound bizarre to many, but look around and every house will have some used dry cell, button cell, or nickel-cadmium battery, not to forget the broken tubelight shell... All these contain toxic chemicals. In many developed countries, like the US, used nickel-cadmium batteries are put into a recycling or disposal facility. In India, they are simply dumped into municipal waste bins, and go on to pollute and poison the soil and groundwater.



Our concerned friend went a step further and tried collecting the so-called hazardous waste generated from his house in a plastic bag. In just a few months, he had a sizeable collection of used batteries and tubelight shells. The way out, says R Santhanam, lies in segregating waste!

Source: Mr R Santhanam, Consultant, Bharatiya Cattle Resource Development Foundation