in the lungs alongwith bringing about constriction of arteries.

Higher intake of nitrates also causes the production of free radicals of nitric oxide and oxygen. Free radicals of nitric oxide have a great affinity to haemoglobin, and the oxygen carrying capacity of blood is further reduced. Free radicals of nitric oxide and oxygen cause dilation of blood vessels along with damage to the cells. Normal functioning of the lung depends upon the balance between the dilation and constriction activity but with excess nitrate in water, the process is disturbed and creates conditions of infection of the respiratory tract.

Inspite of environmental pressure against the use of chemical fertilizers, the deadly substances continue to be used unabated across the world. At the end of the 20th century, an average of 91 kgs of fertilizers were used for every hectare of cropland – an increase of more than a third since the mid 1970s. The developing world accounted for the maximum increase – both agricultural production and fertilizer used increased by about 4% between the mid 1980s and mid 1990s. The consumption of fertilizers and their growth were highest in Asia.

However it is not only the increasing utilization of fertilizers, but also escalated production which creates soil pollution hazards. The green revolution has boosted agricultural production and transformed semi-arid land, but its long term effects on soil quality in India have been ignored. Despite the green revolution, 40% of the world's poor who live below the poverty line and go hungry - are Indians. **Green revolution** has been successful in increasing agricultural production and in greening the land, but the spot of ground where the corn and grass grew has changed beyond recognition. In the thoughtless frenzy to produce more food at any cost, soil in the country has deteriorated. **Industrialisation and urbanisation** have reduced agricultural land to a significant extent. This would mean that over the next quarter of century. India will have to feed its growing population on increasingly destructed natural resources – mainly land – leading to further environmental damage. So, the essential question is, how can we produce enough from our limited land resources ? Or how can we sustain the present level of production without damaging our soil further ? This is a difficult problem. Yet, we can not run away from it. And it can be tackled by **Nutrient Buffer Power Management Technique.**

Let us first review what happened to Indian soils in the last 50 years as far as nutrient management is concerned. The green revolution was mainly caused through application of **chemical fertilizers** to the soil in large quantities to increase the yield of **miracle** varieties of cereals, mainly wheat and rice, which form the bulk of our grain production. The **green revolution fallout** was :

(a) *Breakdown of miracle varieties.*

(b) *Fresh onslaught of pests and diseases, and*

(c) *Build up of potentially hazardous inorganic constituents such as nitrates in the soil, leading to ground water contamination.*

Scientists in India had woken up to the fact that the situation now seems to getting out of control. **Organic farming** is seen as an option, but it is not a solution for a country the size of India. In a small country like Germany, there are huge organic farms, but the total produce is one third of what one would obtain by making use of chemical fertilizers.

The right course is the middle path, clearly understanding the actual dynamics of plant nutrient availability in the soil and fashioning fertilizer recommendations on the precise need. The **nutrient buffer power concept** assumes relevance in this regard.

Plants need external nourishment and the soil needs constant replenishment. In the beginning, the focus of agronomists and soil scientists was on the major nutrients such as nitrogen, phosphorus and potassium. Later, new elements, known as **micro-nutrients,** which were found essential for optimum plant growth, were also added to the list. Attempts to quantify the **availability** of soil nutrients also began.

In a dynamic state of plant growth it is almost impossible to precisely quantify the availability of soil nutrients. The most common approach is to extract a specific quantity of soil with a chosen extractant, measure the nutrient in this extract, calibrate these quantities against predetermined indices and conclude whether the soil has high, medium or low nutrients. The next step is to formulate a fertilizer recommendation based on these values. However, there are inherent limitations in such an approach. Mostly, a laboratory extraction of a specified quantity of soil can never simulate what eventually happens in the field.

The next step is to compare what is extracted from the soil with what is eventually found in the leaf tissues of the crops. One can obtain good results with location specific research, that is, where the study is confined to a chosen number of fields. But when large tracts involving very heterogeneous soils are involved, the results of such studies and the fertilizer recommendations can not match at all. Such empirical soil tests and fertilizer recommendations are primarily responsible for the vast build up of **nitrates** in soils in India. Cases are also there where blanket applications have been resorted to, especially in the case of phosphorus and potassium. Sound soil testing means that we take into consideration the actual dynamics of soil nutrient availability and gear our procedures accordingly.

Of all the parameteres that are crucial for absorption of a nutrient by plant roots, the most important is mean concentration on the root surface in a specific period. In a dynamic state of plant growth this is extremely difficult to quantify. However, it can be measured indirectly by appropriate nutrient uptake models. Using such models and comparing the results with those obtained from routine testing procedures, it has been found that the mean concentration of important macro plant nutrients such as phosphrous and potassium and micro-nutrients such as zinc on the plant root surface is intimately linked to their **buffer power** with regard to the soil. The **buffer power** of a specific nutrient can be quantified by different analytical technologies. **Electro ultrafilration** is the most sensitive and sophisticated technique that can be adopted in well equipped laboratories. Simple **absorption desorption techniques** have also been developed in laboratories of developing countries. The results are almost same. The important point is that once the **buffer power** is accurately quantified, developing a fertilizer recommendation that will precisely reflect crop needs becomes an easy task.

(b) Pesticides— Indian farmers and agricultural technologies have made tremendous efforts in increasing food production during the last 35-40 years. There has been more than a twofold increase in food grains production since 1960-61. This is largely due to the introduction of high yielding crop varieties. fertilizers, assured irrigation and improved agronomic practices. However, to exploit the potential of these improved varieties and to ward- off pests, chemical pesticides became essential. The consumption of chemical pesticides increased to 75,033 tonnes in 1994-95 from a mere 2330 tonnes at the beginning of the planning period. Most of the pesticides are used on crops like cotton, rice, pulses, oil seeds and vegetable crops.

The pesticides are used in houses and fields to eradicate pests and protect stored food grains. They kill many disease transmitting insects, rodents, snails etc, and hence they are immensely **beneficial to man. Pesticides generally belong to two major groups.**

(a) *Chlorinated hydrocarbon insecticides, and*

(b) *Organophosphorus insecticides.*

The **chlorinated hydrocarbon insecticides** are synthetic chemicals which are characterised by the presence of carbon, chlorine, hydrogen and cyclic carbon chains including benzene rings. The three most common chlorinated hydrocarbon insecticides are DDT, BHC, and cyclodiene compounds which are the collective group of cyclic hydrocarbons consisting of such important insecticides as chlordane, heptachlore, aldrin, dieldrin and endosulphan.

The **organophosphorus insecticides** are synthetic chemicals which are some forms of phosphorus. Common examples are Tetramethyl Pyrophosphate (TMPP), Parathion, Malathion, Coumaphos etc.They pollute air and water and finally reach man and animals through skin, respiratory system and gastrointestinal tract.

The **herbicides** (weedicides) are chemicals used for the control of weeds and other unwanted plants. Depending on the mode of action herbicides are of two types. The first category includes those herbicides which interfere with the photosynthetic activity, thus causing the plant to die from lack of energy. Monuron and Simazin are the examples of this kind of herbicides.

The second category of herbicides includes those herbicides whose action is not clearly understood. Al low concentrations, they are used for causing increased retention of leaves and fruits and are used in agriculture for this purpose. At higher concentrations, they cause weakening of the base of petiole where the leave attaches to the stem, thus causing defoliation, but recovery may occur. In certain plants, however, they cause drastic proliferation of tissues of phloem resulting in the blockage of nutrient transport and formation of harmful lesions. There is no recovery from the damage. Examples of this kind of herbicides are 2,4- dichlorophenoxy acetic acid (2-4 D) and 2,4,5 - trichlorophenoxy acetic acid (2,4,5 -T).

Thus **herbicides** can modify plant communities which in turn affect herbivores and then carnivores.

The other biocides like **fungicides** are used to kill the disease causing fungi. They are dangerous to the host if used in large concentrations. The bactericides are used to kill bacteria while **nematicides** are used to kill nematodes. **Rodenticides** which are used to kill rodents may be left to rot but they cause pollution of soil because they are non-biodegradable.

Despite largescale use of pesticides which are basically toxic and do not increase the yield, various states in India have experienced most pest outbreaks like bollworm and whitefly in cotton, BPH and leaf folder in rice, pyrilla and borers in sugarcane, aphid in mustard, and pod borer in pigeon pea. Recent reports of resistance/resurgence of ***Phalaris minor*** in wheat to Isoproturon herbicides in various states such as Haryana, Punjab, and U.P and resistance in insect species like bollworms, whitefly and borers add another dimension to destabilise food production.

The chlorinated hydrocarbon pesticides on land destroy the soil fauna reducing the productive capacity of the soil.

Birds are most affected because of aerial sprays of insecticides like DDT as their nests and feeding sites are near the fields which are sprayed. Birds pickup food from soil, especially when ground is wet, There is thus an indirect source of insecticides for birds as they feed on burrowing animals like earthworms which take a large amount of soil which has been sprayed with insecticides. The chlorinated hydrocarbons interfere with the productive activity of birds like robins, grebes, berring, gulls etc. In birds DDT is reported to cause thinning of egg shells and loss of reproductive capacity as it depresses the activity of estrogen and testosterone, the female and male sex hormones.

The chlorinated hydrocarbon insecticides cause mutations of DNA molecules in man and livestock. They are mainly Central Nervous System (CNS) poisons and elicit a variety of CNS symptoms in man. They also affect the vital organs of the body. A number of degenerative alterations are caused by these insecticides particularly in the liver and kidney. DDT is carcinogenic to man, if its accumulation in human tissues exceeds a certain limit. Both DDT and BHC leave a lot of residual toxicity in vegetables, grains, and plants and hence have a chance of causing cancer.

The organophosphates are actually toxic and affect the CNS causing nausea, abdominal pain, diarrhoea, respiratory problems, lung edema, fall in blood pressure, drowsiness, mental confusion, fever, convulsions, paralysis, coma, and heart attack etc.

Evidence of pesticide poisoning in humans and wildlife, contamination of the ecosystem and high levels of pesticide residues in food articles are also of great concern. The export of agricultural commodities to developed countries has also suffered because of pesticide contamination.

Among pesticides the most important are the chlorinated hydrocarbons e.g. DDT., BHC, aldrin, endrin, dieldrin, lindane, chlordane, heptachlor and endosulphan. Organo-phosphates include- malathion, parathion, ethion, fenthion, trithioin, dursban, dimethoate, phosdrin and metasystox etc. The remnants of these pesticides may get absorbed by soil particles which may contaminate root crops grown in soils. Unfortunately these pesticide residues coexist within biological system with other forms of life. The elimination of pests in the soil must inevitably produce changes and disrupt the balanced natural cycles and food chains within natural ecosystems. Residual herbicides which are applied to the soil at the time of seeding remain active for several weeks and prevent the growth of weeds in competition with the emerging germinating crop.