A BLESSING OF THE PAST CENTURY - BUT MAJOR CHALLENGE FOR THE NEXT MILLENNIUM.

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Completely forgotten, Dr. Fritz Haber, labeled a war criminal, but also a Nobel Prize recipient, should be acknowledged as an individual having the largest environmental impact on this earth. Not because he introduced chlorine gas as a chemical warfare agent during the First World War, but because he developed a method to synthesize ammonia, for which he received the Nobel Prize in 1919. His invention resulted in the industrial production of fertilizer.

Some may wonder why this development was so significant? In order to understand this, one should understand the basic principles underlying organic life or more specifically biological cells. Cellular tissue is made up of proteins, carefully synthesized by the cell's DNA, bonding numerous amino acids together. Amino acids are mostly made with four elements, carbon, oxygen, hydrogen and 'reactive nitrogen'. Simply stated: without 'reactive nitrogen', there would be no life.

Carbon, oxygen and hydrogen elements are readily available, but 'reactive nitrogen' is not, in spite of the fact that 78% of the air consist of nitrogen gas. The problem is the very strong bond between the two nitrogen atoms, which first has to been broken, before the nitrogen can be used in other chemical compounds. Certain bacteria are able to 'fixate' nitrogen gas and symbiotically create 'reactive nitrogen' nodules on the roots of leguminous plants. Lightning can also break the bond and create nitrate, another form of 'reactive nitrogen'. Only when the bond is broken can nitrogen become available as an amino building block for amino acids, thus proteins.

All forms of biological life require nutrients and are part of the food web. Only part of the food that is digested by one form, is absorbed for its own use. Most of the food is transferred into a form now available as a nutrient source for other forms of life. Any particular route through the web, from corn to chicken to human, is called a food chain. These interrelationships of biological life will determine the size and composition of the food web, which basically is reflected in the biodiversity and establishes the ecosystems on the earth. When one form of life increases, it not only increase all life present in its own food chain, but it will also increase other forms of life in a different food chain, which benefits from the food that was not absorbed. When we grow corn, only part of the fertilizer (30%) is used to grow corn, the rest enters the environment and stimulates other forms of life in a different food chain. When we raise animals, again only a part (30%) is used for meat proteins, the rest enters the environment and stimulates other food chains. When we look at how humans prepare their food, may be less then one percent will be absorbed by the body, most of it is discarded into the environment and enters other food chains.

It was the limited availability of 'reactive nitrogen' in this food web that established the earth's biodiversity and ecosystem as we know it and like it. The human participation in this web, prior to this century, barely impacted the Earth's biodiversity, thus ecosystem, since our population was limited and spread out over large areas. When man started to live in villages and cities, food needed to be imported, which consequently also concentrated the waste products. Prior to the

twentieth century, these waste products were collected and brought back to the same fields they originally came from and used again to grow food.

Due to the limiting availability of 'reactive nitrogen', growing enough food to feed the world's increasing human population was a major concern early this century, until Dr. Haber proved that man also can break this nitrogen bond, by converting nitrogen gas into ammonia, a form of 'reactive' nitrogen. This process enabled the industrial production of fertilizer. The explosive growth of the world population, from one and a half billion by the start of this century to more than six by the end of this century, was only possible because of Dr. Haber's invention. It is presently estimated that an astounding one third of 'reactive nitrogen' of all the proteins in a human body originate from synthesized fertilizer. Although clearly a blessing for humans, the impact of this massive introduction of 'reactive nitrogen' on the Earth's ecosystem was unforeseen.

The introduction of new 'reactive nitrogen' itself, was not the only impact. Since it was such a 'clean' and 'easily applied' fertilizer, it made, especially in the industrialized countries, the use of waste products as fertilizer obsolete. The waste products from villages and cities were no longer used as fertilizer and are now basically discarded into the environment. In addition we have seen an enormous increase in the use of fossil fuel, which, when burned, also converts the nitrogen gas in the air into nitric oxide, another form of 'reactive nitrogen'. Although there are natural biochemical processes that will convert reactive nitrogen back into nitrogen gas, such processes can not keep up with the enormous amounts of man-made or man-caused new 'reactive nitrogen', that is entering the environment or food web and consequently is changing the earth's biodiversity and ecosystem. Not only does it impact the food web, its increased presence in all the environmental elements is changing those elements.

The media has been reporting several environmental disasters, such as "Dead Zone in the Gulf of Mexico", "Killer Cells in East Coast Estuaries", "Red Tides", "Acid Rain", "Green Rain", "Destruction of the Ozone Layer", " Smog", "Global Warming", "Point and Non-Point Pollution Sources" and recently the "Odor problems, caused by Manure from CAFO's (Concentrated Animal Feedlot Operations)". Most such disasters are reported as individual, non-related phenomenon and it is disappointing that, in spite of some 'red flag' raising articles in scientific papers, the 'reactive nitrogen' correlation is ignored by our regulatory agencies and consequently our media.

'Reactive nitrogen', an essential part of food elements, also exists and moves within the earth's biological mantle of water, soil, atmosphere and while moving between these elements, it may change its form. In the atmosphere it is mostly present as an oxide or ammonia. In water and soil, it is present as organic matter, oxides and ammonia. It is very important to know how each element is affected by the presence of each form of 'reactive nitrogen'. The increase of man-made 'reactive nitrogen' in the biosphere is not only the result of the burning of fossil fuels and the use of fertilizer by agriculture, but is also caused by the uncontrolled disposal of human and animal waste. Large amounts of oxides, ammonia and organic matter enter directly from sewage treatment facilities, urban run-off, landfills and animal feedlot operations. Although its impact first will be felt in the local environment, it inevitably will spread and affect the entire world's biosphere, thus ecosystem.

The challenge for the next millennium will be to prevent or at least minimize the man-made reactive nitrogen from entering the biosphere. Unfortunately many of the needed measures will interfere with the "economic development" as presently taught in business colleges and universities. To minimize 'reactive nitrogen' in our atmosphere we should either minimize the burning of air or we have to develop new technologies that do not require air to release energy from hydrocarbons, including the re-exploration of [alternative] energy. The economic consequences may include more urban development and less suburban sprawl, smaller cars and houses.

To minimize reactive nitrogen in soils and runoffs, agriculture needs to return to more natural fertilizers and eliminate growing crops that now yield more waste than nutrients for humans. The disastrous environmental problems caused by confined animal feedlot operations (CAFO) should not be considered agricultural, but needs to be regulated as any other 'industrial strength' pollutant. All this clearly clashes with the trend in food production by agribusiness. On the other hand it will encourage agriculture by smaller family farmers, now put out of business by the politically more powerful. It also means that in urban and suburban areas we have to limit the use of synthesized fertilizer and use natural vegetation for landscaping in order to prevent soil erosion and produce oxygen. The excessive use of lawns, requiring fertilizer and water, should be limited.

Most people assume that human waste is properly disposed of, but unfortunately it is only disposed of in a manner that it does not cause a nuisance. While the goal of the Clean Water Act was to eliminate all water pollution, EPA only demands sewage treatment which removes those elements that cause odor problems. Those elements that represent a 'reactive nitrogen' nutrient source, such as urine, amino acids and proteins do not require removal. The same for human solid waste, it is disposed in landfills away from populated areas. Although the 'reactive nitrogen' may be stored and isolated for a while, it eventually will escape and enter the biosphere.

Although solutions dealing with lifestyle and agriculture will require either new technologies or education, this is not the case with the disposal of human and animal waste. Sewage treatment methods have been available at least 30 years not only to eliminate any odor problems, but also to convert the 'reactive' nitrogen back to nitrogen gas. Since such treatment actually is less expensive, there is no reason why the EPA or State regulatory agencies should not demand such treatment, especially since this was the original intent of the Clean Water Act. The same is true for solid waste.

Large cities in Italy, using stimulating recycling legislation passed by Mussolini in the second world war, now recycle all their solid waste impressively, using effective separation technologies solely developed for this purpose. There is no reason why the same approach can not be applied in the rest of the world.

Manure from concentrated animal feedlot operations, referred to as CAFO, is a problem by itself. This type of raising animals has become prevalent in the industrialized world. Due to the large volume of manure, it would require huge tracks of land to properly apply the manure on. The problems that this will cause with storage, transportation and land application, unfortunately makes this most suitable application of manure not feasible.

As a result, attempts are made to solve the environmental problems, again solely as odor nuisance, very similar to how they were addressed when the odors were caused by municipal sewage. Except now that rivers can not be used to carry away the partly treated manure, as is the case with sewage, treatment mostly relies on self contained lagoons, which quickly convert into smelling cesspools. The fact that they cause odor problems proves that they are not 'self contained' and that partly treated manure is emitted into the atmosphere. The solution to pollution is still dilution, only now with air. To find a solution for this problem, we have to answer the questions about economies of scale and if we are we willing to pollute our own environment, so somebody in another country can eat pork chops. Equally important are the ethical questions dealing with the treatment of animals. However, to satisfy the local demand for meat proteins, there probably always will be animals raised in confined areas and therefore there will be an accumulation of manure. In such cases the manure needs to be valued as a resource, whereby the carbonaceous (fecal) waste could be converted into methane gas to be used as an energy source and the nitrogenous(urine) waste into aqueous ammonia to be used as fertilizer.

Like municipal sewage treatment and solid waste recycling, this solely requires a change of attitude, since such 'treatment processes' are already developed, available and economically feasible.

We have been too busy with ourselves to realize that we are active participants in the interrelationships within the biosphere of earth and that we, by nearly five folding our presence, not only have changed the size and shape of the food web, but also are impacting the elements in such a manner that we may not need our nuclear weapons to alter this earth's biosphere. Let's admit our selfishness, ignorance and mistakes. Perhaps our ranting is too reminiscent of 'chicken little', but how many more 'dead zones', 'killer cells', 'smog', 'acid and green rains' and 'red tides' are we willing to find outside our doors?