SAVE THE SOIL - SAVE THE NATION

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"The wealth of a nation is in its soil, its water, its forests and the things they produce and reproduce (Richard L. Porlet)." Soil and civilisation go together. The nations which neglected their soils have gone down in the history. Nearly 2300 years ago Aristotle stated "Soil is the stomach of the plant." Can we hit at the stomach of the plant without hitting at our own stomach ?

Quite often people talk of land, fight for land but most often they ignore the third-dimension of the land, which makes the land a soil. Nation's armies fight for an inch of land, but no body seems to shed a tear when millions of tons of top fertile soil are lost before their eyes by a single storm of rain or wind. Can you believe that India is losing 5 to 6 thousand million tons of top soil every year but did you see any agitation for prevention of this loss or any protest against the misuse of the soil.

The gradual "inch-by-inch" nature of soil erosion is both a blessing and a curse. It is blessing in that it takes time for

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erosion to produce measurable devastating effects. It is a curse in that it does not easily catch the eye of the public except when it causes calamities, such as drought and floods. Huge public expenditure is incurred in fighting flood's damage, desilting, costly water reservoirs,protecting dams, repairing highways, and compensating for loss of property and crops. The ravages by floods in Rajasthan this year, in Uttar Pradesh in 1980, in Gujarat in 1979, and in Bihar a few years ago, are grim reminders of the havoc that these floods are causing. Are we not silent spectators to this drama ? Are we not losing our most valuable heritage that nature has taken millions of years to build and that supported our nation for thousands of years.

We are in danger of losing sight of the fact that the land is limited and that the number of people it is required to support has more than doubled in 30 years; and this process of doubling continues unabated. More people mean many times greater need for food, fodder, fiber, fuel, and timber. These pressures set up a chain reaction involving extension of cultivation to more marginal lands, more exploitive agriculture, more deforestation, and more overgrazing and hence more erosion. Every development project, whether it is construction of an irrigation project, highway, airport, railways, factory, or a new housing colony results in ecological disturbances of the environment and more complex problems of soil conservation. Are we geared to meet this situation ? It is

not the case of India alone,the whole world has the same problem, it is a question of degree. What takes nature millions of years to develop as a productive top soil man can destroy through his negligence and reckless activities in a few days, months or years. At a rate of 10 tons/ha loss of top soil, we may loose the entire top soil in 250 years.

Do we know that each year the world's finite capacity to grow food and fibre is being reduced by the loss and degradation of its soil. First, many of the world's soils are losing the minerals and organic matter that makes them fertile, and these materials are not being replaced, in most cases, nearly as fast as they are being depleted. Second, some soils are being degraded by increase in their salt or sodium content, by waterlogging, or by poisoning through indiscriminate application of agricultural and industrial chemicals. The former is more evident in countries like India and the latter in highly industrialised countries of Western Europe. Third, soil is being lost physically through accelerated erosion from the action of water and wind and by undesirable changes in its structure. Fourth, millions of hectares of good farmland are being covered by water for reservoirs or by buildings, asphalt, and concrete as urban areas expand into the countryside. The net result of these multiple assaults on the world's agricultural soil and land will be that the planet can feed, clothe and house fewer people at a time when world population is growing and expectations

are arising for a better life.

Indian situation analysed

Let us analyse the Indian situation. Since the United Nations conference on environments, which I had the opportunity to attend, a number of papers have appeared emphasising the seriousness of land degradation, but the world has not yet evolved a rational policy on soils. In India we have industrial policy, which we accepted soon after independence and today we can rightly boast of a good ranking in the list of industrialized countries may be of the third world, but do we have a soil's policy ? We do need a land charter and soil's policy for development as well as our survival. Out of 328 million ha total land area, 18 million ha is under urban and non-farm uses, 21 million ha is non-cultivable, about 85 million hectares under forests, non-descript pastures, and grazing lands, 40 million ha is potentially arable but uncultivated waste land and only 143 million ha is under agricultural uses. The National Commission on Agriculture (1976) estimates that nearly 150 million ha approximately half the total land area of the country is in various stages of degradation due to water and wind erosion. Tejwani (1982) estimates that 56 per cent of the agricultural land, 75 per cent of fallow land, 86 per cent of the cultivable waste land, 95 per cent of so-called grazing lands and less than 33 per cent of the area under forest and trees is suffering from soil erosion problems.

Dass and Mukherjee (1980) put these estimates a little higher and consider 175 million ha are subject to soil erosion and other degradation hazards.The problems include water and wind erosion in cultivable and non-cultivable lands, desertification, salinisation, alkalisation, waterlogging, ravines, shifting cultivation and other land degradation processes which account for this land deterioration. About 40 million ha of potentially arable land has been estimated by the National Commission on Agriculture lying barren. Another 43 million ha is under highly deteriorated problem soils such as saline alkali soils, waterlogged soils, ravines, deserts and suffering from many other constraints including ravages by shifting cultivation.

Mr. Vohra (1980) has put these estimates still higher and argues that 200 million ha is degraded due to various causes and deteriorated to various degrees. Though no two estimates agree the fact remains that about one half of the land is affected by degradation in various ways. Thus, it is not surprising that more than half the population is below the poverty line. We call land the mother earth. Can you ever hope to see a healthy child from a sick and impoverished mother?

Natural disasters and soils

Land degradation is the cause as well as the effect of a number of disasters which we consider national disasters. Quite

often erroneously we blame the nature for its wrath and fury without realizing that we are the cause of it and they are directly or indirectly related to mismanagement and unwise use of soil.

Floods: According to National Commission on Floods (1980) 40 million ha are subject to floods throughout the country. The core of the problem lies in the Indo-Gangetic basin particularly in the States of U.P., Bihar, West Bengal, Assam, Orissa and on an average about 8 million ha are regularly visited by floods every year causing an annual loss of about 250 crores of rupees. The annual loss during 1971-80 is estimated at 739 crores. The floods are considered a disaster and wrath of nature and annually crores of rupees are spent in meeting the disaster. It is often not realized that their intensity and extent could be much less but for man's thoughtless action, over exploitation of natural vegetation and forests, mismanagement of soils in the critical areas of watersheds and reduction in the capacity of agricultural lands, to retain water. Thus, soil management is the key to the problem of floods. The most disquieting feature is the rapid increase of the flood affected areas since 1950. The National Commission on Floods has remarked that from 25 million ha in 1950 flood affected area has now grown to 40 million ha. One could argue about the accuracy of these figures but could not ignore the statistics quoted by Member (Floods) Central Water Commission, Govt of India, in the Intl.Conf. on Flood Disasters, held at New Delhi 12 days ago, who stated that from an average 6.95 million ha during

* Keynote paper by Gurcharan Singh, Member (Floods) Central Water Commission of Government of India.

1953-60 the average flood affected area increased to 11.49 million ha between 1971-80. The main reason for this change is the ruthless deforestation, destruction of vegetative cover, lack of soil conservation in the agricultural and non-agricultural lands in the catchments and extension of agriculture to marginal lands without adequate soil conservation measures. Mr. Dass in his paper in the above mentioned conference stated that it was possible to moderate the intensity of floods and their adverse effect by changing the soil moisture storage qualitatively and quantitatively through land use management and by increasing the ability of watershed to absorb, utilize and affect delayed release of water.

Droughts : The other national disaster for which the country has to spend crores of rupees every year in the form of relief or for counteracting its ravages of reduction in crop production and instability of production is the drought. Nearly 80 per cent of the area of the country is semi-arid and arid and droughts of a few days to few weeks are most common throughout this area. There can be climatic drought, soil drought and often both. Insufficiency and illdistribution of rain is one aspect which is not changeable. The capacity and ability of soil to absorb and hold the water and use it effectively is manageable to a considerable extent. Through mismanagement of soils, lack of vegetative cover and poor structure, millions of ha of droughtprone areas have lost their capacity to make

the best use of the rain. The problem is worst in shallow soils. Thus some soils are inherently droughty because of their shallow depth but others are made more droughty by man. You would be shocked to know that in Sholapur region of Maharashtra in 75 years the area under deep soils (>45 cm) decreased from 46 to 29% (Patel et al. 1981). Thus before our own eyes these profound changes are occurring. Worst affected are cultivable waste lands and denuded forest and grasslands which everybody seems to have the right to exploit but nobody considers his duty to protect and improve. Many of these are government lands or village common lands. Most susceptible areas are the areas of Peninsular India, Western India (Rajasthan, Gujarat, Maharashtra) and parts of U.P., Bihar, Haryana and Punjab. Dass and Mukherjee (1980) concluded that the total area susceptible to drought is about 259.7 million ha which is nearly 75 per cent of the country's total land surface area. Modern technology no doubt has been able to blunt the effect of drought considerably but still it remains most destabilising factor in agriculture of the country. Extension of irrigation is considered a means of fighting the drought but with all our best efforts still one half of the cultivated area will remain unirrigated, which is the core of the drought prone areas. The only hope of this area for fighting droughts is through sound management of rain water and of soils. The main question is whether the country spends funds on relief measures to mitigate the hardship to people or makes a deliberate

effort to develop the land and to introduce a technology to fight droughts and to give more stable production. We can find enough funds for meeting the disaster but not for soil improvement.

The rain water management technology assumes a great importance in India and national policies should aim at encouraging the effective use of rain water. The INSA Seminar, 1980, on Rainwater Management gives concepts and policies for this system and presents an evidence of the availability of such a technology for meeting the challenges of drought in the SAT areas of India. An effort is needed to transfer this technology which has potential of increasing crop yield as well as reducing soil erosion in millions of ha of land in India.Water can be a catalyst of a change.The story of Sukhumajri is an example.

National problems related to soil constraints or poor soil management

Now I deal with another category of problems, which are not called disasters but are of such dimensions and nature that they are of national significance. They are related to soil constraints and poor soil management.

Food shortages (food famine) : Food shortages have been common in India and even after more than 30 years' developmental activities since independence, we are still not free from the problem of food shortages. No doubt famines which were of common occurrance have

become less conspicuous but the food imports still persist. From 143 million ha of cultivated land which includes more than 52 million ha of gross irrigated land, still our average production is less than 1 ton/ha. There are variations from state to state, and district to district but the fact remains that we are producing only 1/5 to 1/4th of optimum yield potential of these lands. The most unsatisfactory situation is of kharif cultivated area which show too much fluctuation in yield from year to year, worst instability being on oilseeds and pulses. We often blame the weather but even in irrigated areas the yields are disappointingly low. Take the case of wheat, we have average yield of 1694 kg/ha from irrigated areas as against more than 5000 kg in Netherlands and 3616 kg in Mexico. The average yields obtained at the research stations, at the farms of innovative farmers and the average yields of the country show a tremendous difference. The ratio is as wide as 4:2:1 in irrigated and 7:4:1 in unirrigated areas.

I am convinced that even half of our 52 million ha of gross irrigated area if cropped intensively and with all the inputs is capable of producing more than 200 million tons of food grain and meet our total requirement of food grains even in the year 2000 A.D. The results of national demonstrations on farmers' fields indicate that the optimum production potential is more than 400 million tons. But this is possible to achieve not with traditional technology, traditional varieties and subsistance farming. It is possible only with modern technology. This is a dynamic process in which input-output relationship has to be kept in view to ensure optimum returns and to avoid any ill effects of inputs.

The non-irrigated rainfed lands are producing less than 800 kg food grain per ha. Besides their low productivity, they are more prone to erosion by wind in arid areas and by rain water in the semi-arid areas. Even the practices of cultivation such as fallowing during monsoons, removing all the stubble, overgrazing, ploughing up and down, and neglecting use of fertilizers and manures and traditional technology for crop production results in accelerated erosion and poor production. We have sufficient experimental evidence that these rainfed lands are capable of producing many times more than they are doing now, provided we remove the soil constraints and manage them efficiently. ICRISAT's experience on deep black soils (Vertisols)has shown that 12 million ha of these which remain uncropped during monsoon season losing on an average 25 per cent of rain water and about 6.9 tons of soil per ha annually could produce nearly 36 million tons of additional food grains (Kanwar, 1981). With appropriate technology, Vertisols will produce not only 500 per cent more food give 600 per cent net returns and reduce soil loss by about 80 per cent and water loss by 60 per cent. Similar experience exists in case of Alfisols(Red soils) which occupy 94 million ha in this country. The experience of Soil Conservation Research Center, Dehra Dun and All India Dryland Research Project, provides convincing evidence of the reduction in soil and water loss that could be affected through improvement in productivity of the land.

An idea of soil losses per ha is given in Table 1.

Thus it is logical to conclude that the low productivity of the soil is responsible for extension of agriculture to marginal lands, accelerating erosion, and increasing soil degradation. By increasing productivity the country can retire or revert marginal lands to forests and grasslands and improve the ecosystem. It is criminal to be contended with low productivity.

It is not only the agricultural lands whose productivity needs to be increased, the forests and grasslands also are in need of increasing the productivity as more vegetative cover would mean less erosion and less loss of water through runoff.

For saving the precious heritage of the soil, we should consider a few points. These are:

1. Soil should be considered a national asset and every land holder be considered its custodian and expected to use it according to its capability, to realise its optimum potential.

2. It should be recognized as a national policy to bring the deteriorated lands back to normal production and to prevent the deterioration of the land. Tax relief incentives and other monetary benefits to encourage this process should be provided.

3. Every one should make an effort to return to the soil what he removes and improve it further so as to leave

a better soil for the future generations.

Fuel wood shortages : The shortage of fuel wood and increasing demand for it by the galloping population leads to rapid deforestation of areas and degradation of land. The National Commission on Agriculture has estimated that the country may need 225 million tons of fuel wood to meet its minimum needs for the domestic purposes by 2000 A.D. There is a good deal of evidence that ravine lands, saline alkali soils and all the lands considered unsuitable for agriculture could be put under forest and fuel wood plantation. The techniques developed by the Central Soil Salinity Research Institute, Karnal, of planting quick growing trees by drilling holes in the sodic soil and using gypsum manure, fertilizer and rice husk for facilitating aeration and water penetration can convert million of ha of such waste lands in U.P. and other states into good forest lands. This may be the easiest way of making the best of these deteriorated lands and improving the ecosystem.

Water and energy shortage: The scarcity of water and energy are also partly the results of indiscriminate deforestation and absence of soil conservation in the watersheds. The water runs off the bare ground instead of soaking in, thus the capacity of the catchments to yield continuous supply of water, particularly during the dry season and to keep our power plants running is reduced. We have also neglected

5 lac tanks which dotted whole of the peninsular India and some parts of north India as well. We have also encroached upon their watersheds and allowed them to be silted up and lie out of repair. This has seriously affected the ecosystem and created more runoff water which causes damage to agricultural lands and reduces availability of water in the dry periods. A vigorous soil conservation program in the watersheds and afforestation of denuded forests and barren non-agricultural lands is needed. To solve the problem of shortages of the present and to provide for the future, techniques are available to prevent erosion from different types of soils, but unless the soil conservation becomes a mass movement and individual farmers' priority program the job can not be done. Nation wide efforts are needed to retain as much water in situ as possible and harvest excess water in tanks and small reservoirs all over the watersheds in the country. Unless this is done the huge loss of rainwater which goes to the sea unutilized cannot be reduced. While the country suffers from droughts, water shortage and power shortages, the mighty rivers carry the good quality water to the ocean. Isn't it strange ?

Siltation of tanks and reservoirs : One of the most serious problem experienced in India is siltation of the costly irrigation water reservoirs, dams, canals, and tanks. Due to siltation their effective life is being reduced rapidly. The actual rate of siltation of dams is many times faster than it was estimated by the designers. The trend

of sedimentation varies many times the designed capacity (Table 2) The life of irrigation dams is shortened. There are serious doubts about the soundness of large dams which besides being too costly require deforestation of thousands of hectares. A conservative estimate shows that 400,000 ha of land had to be deforested for construction of dams from 1952 onward whether it is Nagarjunasagar Dam in A.P., or Bhakra Nangal Dam* in the alluvial soil region of Himachal Pradesh, the story is the same. They are silting up at a fast rate and thus reducing their effectiveness because of the serious erosion problem in the watershed areas.

The system of small tanks needs a critical look. These tanks have sustained Indian agriculture for hundreds of years and they can still do it, provided we protect them. Small is beautiful and more efficient too.

Salinity and Alkali : Most of the area in the country being semi-arid and arid, the problem of salinity and alkali is a natural phenomenon. It has been estimated that about 7 million ha are affected by salinity and alkali and 6 million ha with waterlogging and the problem is increasing in the newly irrigated areas.

The major causes of the problem are interference with the surface and subsurface drainage, seepage from the canals and irrigation channels and poor management of water. Irrigation can take

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* It is 400 percent in the former and 133 percent in the latter.

considerable blame for rendering million of ha saline mostly under arid conditions and alkali (sodic) under semi-arid conditions. Abrol and Bhumbla (1971) have estimated that more than 2.5 million ha of sodic soils are lying waste in U.P. and adjoining areas of Haryana and Punjab. The sodic soils have low infiltration rate because of high amount of exchangeable sodium. Thus most of the rainwater runs off the ground causing flash floods and damage to crops in the surrounding areas. All new irrigated areas are faced with this problem particularly in the black soil region. The history of the Chambal project is an index of the rate at which the soil deterioration in the black soil region occurs. What happened in canal areas of alluvial region in 30-40 years may perhaps happen in less than 10 years in black soil region because of the nature of the clay and poor surface and subsurface drainage. It is unfortunate that irrigation is considered only an engineering feat and the duty of the engineer ends after the construction of a dam. The drainage and development of proper system of water use and management is completely ignored with the disappointing results. Low realisation of irrigation potential, deterioration of land and low payoff from the costly irrigation projects is the result.

Prevention of the problem in the newly irrigated areas and reclamation of the deteriorated soils in other areas is the answer. The recent work at the Central Soil Salinity Research Institute, Karnal has shown that these deteriorated soils are highly responsive

to management including land shaping, water management and use of improved technology. Use of gypsum fertilizer manures and other agronomic practices has produced from these deteriorated soils food grain more than 7 tons/ha/annum at the farmers' fields.The technique is becoming popular with the farmers who find the operation very remunerative. Fortunately, the quality of ground water in the sodic soil areas of India is good and can be used effectively for crop production. It is unfortunate that we have ignored the basic principle that irrigation and drainage go together and water alone is not enough for obtaining high production from the irrigated areas. We have also ignored the lessons from the history that many civilisations were ruined because of lack of appreciation of these principles. Pakistan has about 11 million ha affected by salinity and alkalinity out of 15 million ha of irrigated area. The story is similar in Iran, Iraq and Egypt. With more irrigation we can develop better agriculture but by ignoring the basic principles which can make irrigation productive, we can ruin our national heritage. Thus effective field drainage to take away excess of salts from the irrigated areas of arid and semi-arid region of the country is essential for getting the maximum pay off from the irrigation projects and for preventing the deterioration of environments.

Desertification : National Commission on Agriculture (1976) has estimated 32 million ha is suffering from wind erosion out of which 6.5 million ha is under sand dune and the rest of the area shows effect

of wind erosion to varying degrees. We can go on arguing whether the Rajasthan desert is extending to good agricultural lands or not, but fact remains that over grazing, over stocking, deforestation, bringing under cropping those marginal lands which are more suitable for controlled animal grazing, lack of soil conservation measures and nutrient and moisture stress aggravate the desertification process. Man is to be blamed more than nature for the increase in desertification. Man can make the deserts bloom again not only through irrigation but also by proper use of technology suited for arid areas. The Central Arid Zone Research Institute, Jodhpur has done an excellent work in developing technology for protecting these lands. What is needed is an action plan to make use of the technology.

Other special problems of soil erosion: In the foregoing pages, I have described a few problems which become the national disasters and catch the headlines in the newspapers. The soil conservationist will say these are nothing but effect of water and wind erosion. These are not the only aspects there are many other localized effects such as land slides in the Himalayas, ingression by sea on the coast of Kerala and other coastal states, ravines of the Chambal, Jamuna, Sabarmati and other rivers in Uttar Pradesh, Madhya Pradesh, Rajasthan, and Gujarat which bear the stamp of man made problems. The solution of all these lies in the proper management of soil and water. If this process goes unchecked, we will rue the consequences.

Soil health : In the tropics and sub-tropics the rate of oxidation of organic matter is rather high and as the new lands are opened up for cultivation, the organic matter starts disappearing rapidly. Under shifting cultivation system the rate of loss of organic matter is rather high. The recent trend of 5 year rotation instead of 20-25 years in the shifting cultivation areas under tribal communities of India is causing accelerated erosion and impoverishment of the soil.

The exploitive agriculture aiming at maximising production per unit area per unit time also means greater strain on the natural reserves of the soil and unless the input-output relationship is maintained, serious problem of soil exhaustion can become evident. Judging from the trends, I feel if fifties was a decade of N deficiency, sixties of P deficiency, seventies of Zinc deficiency and the eighties may become a decade of multiple nutrient deficiency. Today Punjab is talking Mn and Zn deficiency, Tripura of Zinc, Gujarat of B and Ca and many states of Zn. Although gross statistics are misleading, in 1969 52 per cent soils were deficient in N and in 1980 62.7 per cent have been reported to be deficient. The consumption of P and K has increased 77 and 55 times respectively in 1978-80 as compared to the base year of 1954-55. Whereas in the case of N it has increased only 35 times during the same period.

In intensively cropped district of Ludhiana(Punjab) which claims the highest average yield of wheat 82 to 99 percent wheat fields are deficient in Zn and in Tamilnadu in rice areas deficiency of Cu,Zn,Fe and Mn is 62, 35,28 and 22 percent respectively(Takkar and Randhawa,1978).

Over 130 m tons of food grains which we are producing today are removing about 18 million tons of nutrients as against 12 million tons of nutrients by about 100 m ton food grain in 1970-71. Through fertilizers we are adding only 5.3 million tons of nutrients and possibly 5 million tons from organic sources, still leaving a net balance or overdraft of 9.7 mil. tons on the soil bank. Can any bank remain solvent with such overdrafts? We also should not forget that annually we are losing 8.4 million tons of nutrients through soil erosion. I suggest we regularly prepare a health bulletin of our soils. For this purpose we should fix one hundred benchmark sites or reference points for every one million ha of net cropped area and get their soil samples analysed once in three years. It will help in preparing a health bulletin about the soil and monitoring the changes. Dont we prepare price index ? Should not we undertake to prepare a health index of the soils of the country ? It is high time that the National Bureau of Soil Survey and Land Use Planning, Soil Testing Labs and Fertilizer Association of India undertook this responsibility of regularly monitoring and preparing health bulletins of the soils.

. Besides exhaustion of nutrients, the building up of some mineral elements such as Selenium, Flourine, Sodium, Lithium, and Copper in toxic amounts which can be injurious to the health of animals and human beings also needs to be monitored. Many of these mineral elements are building up in toxic amounts through irrigation, rise of salinity and alkali. Examples of these are reported from Punjab and Andhra Pradesh. The affluents of industry are also adding many toxic elements to soils and we should monitor them.

Another aspect which needs attention is the movement of minerals from soils into underground waters which may become a health hazard. No doubt soil is a great sink, filter and detoxifier for many injurious chemicals but there are evidences of accretion of such injurious substances particularly nitrates into potable waters which can become health hazards. If in Punjab the nutrient consumption has gone up from less than 1 kg/ha in 1950 to more than 107 kg/ha in 1980, it may reach the similar levels as in the Netherlands or Japan by 2000 A.D. The consumption of pesticides will also increase simultaneously. This will lead to considerable rise in the amount of nitrates and injurious chemicals into ground waters. we realize, we can't avoid it, but we can certainly monitor and apply corrective checks wherever needed.

Introducing plants suited to the environments is a time honoured practice but tailoring plants to suit the special environment of particular nutrient deficiency or toxicity is a new development. Through conscious efforts of genetic engineering it is possible to use plant cultivars to make use of particular environments, instead of trying to change the environments. This is the principle of living with the nature instead of going against it. Brazil has achieved a wheat revolution by using aluminium tolerant variety of wheat in highly acid soils. Punjab is already cashing on IR-8 type rice varieties which are more tolerant of sodium in soil complex. Numerous possibilities exist but soil scientists and breeders should work together to exploit this potential.

Let me emphasize that there is no escape from greater use of fertilizers, manures and pesticides and irrigation water for obtaining higher production from less of land in future, but with constant vigilance we can face the challenges as they come. All our efforts should be directed to improving efficiency of these inputs so that their adverse effect on the environments are lessened. More recourse should also be made to exploiting the biological nitrogen fixation through Azolla, blue green algae, Rhizobial culture and Azospirillium bacteria etc. so as to lessen the need for addition of fertilizers which are the highest users of energy.

The crop residue and agricultural waste management has not received adequate attention in this country. They are most useful for improving soil health. It is frightening to see millions of tons of rice and what straw being burnt in the fields of Punjab and Haryana which besides depriving the soil of their beneficial effect is creating health hazards for the people. The scientists and technologists need to work together to use some of these residues for industrial purpose and to use the rest in improving health of the soil. I believe the farmers have resorted to this practice in their situation of utter helplessness. Can something be done, is the question.

Urbanisation and alienation of prime agricultural lands for non-farm uses

No discussion of the soil problems will be complete without mention of the effect of increasing urbanisation on the soil and society. The rate at which urbanisation is going on and the need for land for civic uses increasing, is simply alarming. The axe is

falling on the prime agricultural lands. With a rational land use policy marginal lands could have been put to such non-agricultural uses. India has 18 million ha under non-agricultural uses and the rate of urbanisation may claim twice as much land for meeting the needs of the urban society, industry, highways, etc. by the end of the century. Unless a rational soils policy is adopted very important prime agricultural land will become victims of such non-agricultural uses. Besides this a huge amount of top soil is being used for brick making. I don't wish to frighten you with the statistics but the fact remains that the demand is terrific. These excavations besides taking away the top soil also look like blisters on the surface of the land and cause serious interference in the drainage of the area. Time has come that we look into the possibility of using the soil from deeper layers instead of spreading in horizontal directions. Of course the question of cost benefit relationship will be the determining factor.

Time for a national soils policy

With today's technology we can certainly modify the soils to man's advantage. We can predict the changes and improvements if we know our soil well and quantify the input-output relationship. We could computerize irrigation schedules, fertilizer needs and likely behaviour of soils to management. I consider eighties a decade of

integrated soil management system or better soil-water-plant management system in which all scientists, planners and farmers work together to save the soil, improve its health and make it produce to its potential capacity which is very high. I repeat, save the soil, save the nation. Unless we treat our soils well, time is not far off when we will say we dont have enough land for producing food, not enough fuel for cooking the food, not enough water for our farms and factories, not enough energy and hot enough space to live in and clean atmosphere to breath in. We need national soils policy to save, improve and utilize our soils to their best capability and potential.

In conclusion, I may state we should know our soils, understand their problems, remove their constraints to production through use of technology and sound management system. We should recognize that man is the cause as well as the victim of the soil problems. Whether there are disasters like floods or droughts, food famine, water,energy crisis or health hazards. The land resources are shrinking and quality of land deteriorating and we have no option but to produce more and more food, fibre, and fuel from less and less of land. We have the capacity to do but we need the will to do it and a national soils policy to accomplish it.

Table 1. Annual soil loss due to water erosion on cultivated fields

Location	Soil loss (ton/ha)	Source
1. Dehradun	29 - 38	Consolidated Ann.Report of Soil Cons.Res.Demons.Trg. Centre, 1968.
2. Agra	20 - 32	"
3. Kota	2.5 - 4.0	"
4. Ootacamund	25 - 39	Soil and water cons. res, 1956-71,ICAR Publ. 1973.
5. Vasad	2.3 - 20.4	"
6. Manjri	17.5 - 90	Kanitkar, Dry Farming in India, ICAR Publ.1968
7. Sholapur	42 - 75	"
8. Bijapur	23.0	"
9. Hagari	16.0	"
10. ICRISAT, Patancheru		J.S. Kanwar (1981).Problems and potentials of Vertisols and Alfisols - the two imp. soils of SAT-ICRISAT expe- rience. Intl.Symp.on distri- bution,characterization and utilization of problem soil Tsukuba,Japan, Oct. 19-26,1
(a) Vertisols (Kharif fallow)	6.9	
(b) Alfisols	2.8 - 5.0	
11. Shillong	5 - 76	A. Singh (1981) Engineering Procedure for efficient land use. J.Agr. Engg. March, 1981.

Table 2. Observed sedimentation rate expressed as a percentage of designed sedimentation rate for some selected River Valley Projects in India

Name of River Valley Project	Observed sedimentation rate expressed as a percentage of designed sedimentation rate(%)
Tungabadhra	420
Bhakra	143
Hirakud	143
Ramganga	410
Nizamsagar	2290

* Computed from the data given in "Handbook of Sedimentation" Govt. of India, Ministry of Agriculture, New Delhi 1972. pp.7-8 & 7-9.

REFERENCES

Abrol, I.P. and Bhumbla, D.R. 1971. Saline and alkali soils in India - their occurrence and management, World Soil Resources Report 41, FAO, Rome.

Dass, D.C. and Mukherjee, B.K. 1980. National perspective on soil and moisture cultivation, Agricultural Engineering Today: 4(3):pp.11-17

Kanwar, J.S. 1981. Problems and potentials of Vertisols and Alfisols - the two important soils of SAT - ICRISAT experience, International Symposium on distribution, characterization and utilization of problem soils, Tsukuba, Japan, October 19-26, 1981.

National Commission on Agriculture, 1976. Govt. of India, Ministry of Agriculture and Irrigation, New Delhi.

National Commission on Floods, 1980. Govt. of India, Ministry of Agriculture and Irrigation, New Delhi.

Patil, N.D., Umrani, N.K., Shende, S.A., Manke, B.S., Kale, S.P. and Shingte, A.K. 1981. Improved crop production technology for drought prone areas of Maharashtra, Tech. Bull., Mahatma Phule Agricultural University, Dry Farming Research Station, Solapur, India.

Takkar, P.N. and Randhawa, N.S. 1978. Micronutrients in Indian Agriculture, Fertilizer News. 23 (8): pp. 3-26.

Tejwani, K.G. 1982. National Soil Policy for India, paper for 12th International Congress of Soil Science, New Delhi, 8-16 Feb., 1982

Vohra, B.B. 1980. A charter for land, Sardar Patel Memorial Lectures, All India Radio, New Delhi, December 22-23, 1980.