

## Role of Earth Sciences in Solving Problems of Our Country-side

Agriculture and Mining are two industries crucial for the progress of our country. More than 70% of our people are engaged in agricultural operations. The prime attention of scientists in the country should, therefore, be directed to solving the problems faced by the agriculturist. We, as Earth Scientists, will have to ask ourselves the question whether we have any role to play in this endeavour of making agriculture a success, a sustainable industry and not a yearly gamble in rainfall? I wish to enter a strong plea for Earth Scientists to give increasing attention to agriculture—to the study of soils and water resources, the two vital life-sustaining natural resources essential to human existence.

### *Study of soil to be our primary concern*

Of these, soil is the most important, as it forms the basis of all agriculture and of human civilization itself. At present, little or no research is mounted by Earth Scientists in obtaining a deep and intimate understanding of the process of soil formation. Such studies should not be dismissed as the concern of agricultural scientists. There are many vital aspects of soil formation which are of primary interest to geologists. A close interaction between geologists, chemists and soil scientists has to be forged to achieve progress in this field of prime concern to a large section of our population.

The entire process of evolution of soil, starting from the unaltered rock—be it basalt, or granite, or sediment—should clearly be our concern. Soil is a complex, living, fragile medium that must be protected and nurtured to ensure its long-term productivity and stability.

What are the common soil types of our country? What are the differences between them? Are these differences related to the rock type or to climate? What is the role played by vegetation cover, topography and micro-organisms in changing the soil type? What is the time taken for soil formation? These questions require to be satisfactorily answered. It is logical and reasonable to expect that a good percentage of the research effort in the Institutes of Technology, National Laboratories and other higher institutions of knowledge which have come up in different regions of India should be directed towards understanding the process of soil formation.

### *Black soils of India*

The black soils of India covering an extent of over 100,000 km<sup>2</sup> are some of the world's best soils comparable to the chernozems of Russia. These soils through neglect and over-irrigation are getting degraded and thousands of hectares are being taken away from agriculture due to erosion,

salination and exhaustion. The extent to which indiscriminate application of chemicals is contributing to the exhaustion of the soil requires to be examined.

### *Study of sediment load carried by our rivers*

A systematic measurement of the sediment load carried by our rivers will reveal the enormity of the havoc caused by soil erosion. How much of this is due to land preparation practices and how much to the inherent character of the soil itself has to be evaluated. Micro-organisms obviously play a major role in soil formation and in maintaining earth's life-support system. One has to be, therefore, very careful in tampering with this system. Soil is as much a non-renewable resource as fossil fuels.

### *Lessons our forests can teach*

In our natural forests is preserved species diversity and genetic diversity. Virgin forests seem to sponsor their own fertility. They do not require pesticides and are in some way protected from epidemic diseases. What makes these forests perpetuate themselves without any additional inputs? This requires close attention by our researchers. Should our agriculture become increasingly dependent on fossil fuels? Can forests teach us how to manage our agricultural operations in a better way? Is biological diversity necessary for making significant advances in agricultural productivity? Are we on the wrong track in following monoculture? Have we neglected the role of micro-organisms in enriching the soil through their metabolic activity? While organic manure induces greater microbial activity, fertilizers and pesticides may kill the organisms.

Trees have a deep penetrating root system and help in better infiltration of water into the soil. Some trees are known to free nitrogen and contribute to soil fertility. These require to be cultivated. Tree farming can be an effective way for reducing water scarcity, halting encroachment of desert conditions, preventing water logging and erosion.

### *Understanding the wisdom of Nature*

Land, water and forests are our most valuable natural resources. They have to be zealously guarded against misuse. They not only serve our immediate needs but can be handed over to coming generations as important assets.

Molecular biology and genetic engineering have made important advances, but their study is not directed to solving ecological problems in agriculture. There is need to understand the wisdom of Nature. Rural people are deserting their farm lands and are running to cities attracted by the pampered gay life of the cities. Farm lands are lying waste. The advantages of biotechnology have not filtered down to the farmer making his occupation pleasant and profitable. The vast human resource is lying waste without motivation to better effort. Social action, technology transfer and persuasive policies of government are essential to make a success of agriculture. Every one in the country-side should get engaged

in one kind of project or the other—levelling of ground, erection of contour bunds, reforesting bare hill slopes, draining of land and restoring top soil. There should be no idle hand anywhere in the country-side. For maximum food production, the three basic needs are soil, water and sunshine. India has all the three. The only thing wanting is the will to make the best use of the available resources. How to motivate our people to increased effort should be our main concern. Government agencies have failed in the past. Politicians are in pursuit of power. Our only hope lies in the revival of voluntary agencies. The examples of the Red Cross and the Ramakrishna Mission are before us. Such agencies fired with a spirit of service and sacrifice should come to the fore.

#### *Soil moisture*

The distribution and movement of water through the soil horizon is at present little understood. The filling and emptying of pores in soil by water should form a subject of intensive study. What happens to rain water when it falls and spreads on the soil surface? Is the filling and emptying of pore spaces continuous or does it occur in jerks and jumps? Laboratory experiments have to be mounted in understanding this process. Can the infiltration process be artificially accelerated and more and more of the rain water allowed to reach and augment underground storage?

The composition of air held within the pore spaces of the soil too is important. Temperature changes cause expansion and contraction of the air in the soil. A whole range of changes are believed to set in when temperature changes are caused through rain, irrigation and evaporation. The aeration of the soil is a factor of great importance for the proper growth of plants.

#### *Soil erosion and its prevention*

Earth Scientists should get interested in all programmes of protecting the soil and keeping it where it is and not allowing it to get wasted and washed away to the sea. It should be realized that soil loss is more serious than the exhaustion of metals or fossil fuels. Practically, no research is being carried out in developing an agricultural system that will conserve soil, sponsor nitrogen fertility, manage water effectively, control insects and weeds through biological as opposed to industrial and chemical means.

Reforestation of hill sides, prevention of sheet erosion, and providing adequate drainage to irrigated fields, feeding of optimum quantities of water to standing crops, preventing excess irrigation—all such practices aimed at restoring and preserving the top soil should become the concern of all of us. To what extent our productive soils and our groundwater resources are getting polluted through addition of chemicals requires closer study. A time has come when increased attention has to be given not only to answering the problems faced by the farmer in rural India, but more particularly, to the transfer of knowledge gained by research to the farmer who is the ultimate beneficiary.

*Salinity of soil*

Spread of salinity in our soils is reaching alarming proportions. Excessive irrigation, indiscriminate removal of deep-rooted trees and shrubs have tended to raise the water table in irrigated areas bringing with it salts that were buried deep in the soil. Hydrogeologists should give attention to this problem and suggest adoption of remedial measures.

*Better water management*

The extent to which soil moisture should be maintained for optimum growth may have to be fixed for each region and every modern gadget commissioned for use, not only for maintaining a continuous record of moisture in the different layers of the soil, but also to device mechanisms for feeding only the right quantity of water and not more. One should not hesitate in bringing in computers for regulating the water supply to fields. This could be tried initially in experimental farms and extended to wider regions as knowledge in newer techniques gets accumulated. Better water management is the need of the hour. Hence, meteorologists, soil chemists, physicists, geologists, agricultural experts, should put their heads together in solving the problems of our country-side.

*Rainfall and its distribution*

Compared to many other parts of the world, India is fortunate in getting a sufficiently adequate annual supply of water by way of rainfall. The supply, however, is not uniform and is not evenly spread out, which creates all problems. The distribution of rainfall has to be carefully measured in more evenly-spread network of rain gauges. There is need for a large number of weather stations, keeping accurate record of the quantum of water falling on the land, of water lost through evapo-transpiration and of changes in soil moisture during different seasons of the year. Knowledge gained should be disseminated so that it can be put to practical use by involving the farmer at the grass-roots level.

*Sprinkler and drip irrigation to be made popular*

Our farmers should be financed and encouraged to adopt practices based on latest technology like sprinkler and drip irrigation. Israel which receives a rainfall of less than 200 mm has many lessons to teach us in the matter of water conservation and water harvesting. Investment on such practices as sprinkler irrigation and drip irrigation is far more important than the execution of major irrigation projects at enormous cost. Farmers should be encouraged to grow more and more of high value products like fruits, flowers and vegetables and improve the return from the land. One way to open the eyes of farmers is to have model farms at different centres, demonstrating the advantages of adopting latest technology.

*Conversion of waste land to orchards—Horticulture*

The country cannot afford the luxury of leaving large extent of land as waste. Degraded soils should be identified for reclaiming them. Horti-

culture does not require irrigation. Tree growth, on the contrary, makes the soil receptive to moisture. A country-wide campaign has to be started for converting waste lands to horticultural farms. Bare hill slopes have to be covered with trees. This will effectively slow down soil erosion and prevent the large-scale siltation of dams now taking place, reducing their utility. Contour trenching and farm ponds have been proved to be the simplest and cheap water conservation system which should be widely practiced to allow water to percolate and augment groundwater resources.

Tree farming should, therefore, be promoted on a grand scale. This is the only effective measure for fighting water scarcity, encroachment of desert conditions and salinity of soil.

Entrusting work to Government agencies more often end up with expenditure on paying salaries to staff leaving very little for the actual implementation of the programme. Voluntary agencies should be involved. There is great urgency for involving modern techniques of rain-water harvesting and artificial recharge to groundwater storage.

#### *Benefits of conservation of rain water*

Blasting of the hard laterite crust by means of drill holes 25 to 35 cm deep is known to effectively disintegrate the soil and allow water to percolate. The effects of such simple devices to augment water resources and arrest soil erosion have to be studied. The benefits of conservation of rain water are unlimited. As an example of indigenous research, I would like to draw the attention of our readers to the efforts of Vinayaka Rao Patil of Pune. He has cultivated *Jatropha caucis*, a hardy plant adopted to semi-arid and arid conditions with low fertility and moisture demand. The plant, it is stated, could be propagated by seeds as well as cuttings. What is more important, the plant appears to be capable of producing 1500 litres of oil from an acre of ground and the oil can be used as a substitute for diesel in running irrigation pumpsets! (*Economic Times*, Nov. 23, 1990, p. 3)

#### *Ecological balance*

The relation of plants and animals to one another and to their surroundings, in other words, their ecology, should receive increasing attention. The creation of natural ecosystem which sponsors its own fertility, like virgin evergreen forests, where nutrients are recycled and epidemics avoided would form a worthy goal.

Traditional agricultural practices had this aim of living harmoniously with Nature. These practices should not be rejected outright and alien methods too much dependent on fossil fuels be blindly copied. If making more and more money is the only aim, even murder and mayhem can be justified. The way we are treating our soil resources is nothing short of murder. Loss of soil and pollution of soil and groundwater with chemicals will lead to untold misery, if not arrested in time.

Can we in India, make a success of agriculture without too much dependence on chemicals and fossil fuels? Can pests be controlled biologically without recourse to chemicals? Our scientists should seriously attempt to wrest the secret of Nature which aims at self renewal without

external aids (as in the case of virgin forests). What is badly required is a marriage between modern science and traditional agriculture with a view to conserving soil, and water resources. Farmers and scientists are not two different species. They should talk to each other as equals and devise methods of living decently on land.

*Wasteful utilization of funds*

The substantial amounts of loans and subsidies amounting to crores of rupees have not gone to the improvement of land. They have got diverted to the purchase of fertilizers, diesel oil, machine spares and the like, representing money which has gone out of the country. Instead of benefitting the farmers, they have contributed to the prosperity of multi-national corporations manufacturing fertilizers and pesticides, the distributors of these products and the growing tribe of middlemen who fatten at the cost of the rural poor. The bulk of the research effort on biotechnology is financed by multi-national corporations whose sole aim is to make quick money. They are least bothered about the long-term ill effects. If this practice is allowed to go unchecked Indian agriculture will be at the mercy of the multi-national corporations.

Green revolution has no doubt achieved spectacular results. Yet, agriculture in the country cannot be stated to be in a healthy condition. The full potential of the agricultural sector has yet to be reached. Those dependent on agriculture are still steeped in poverty. A quarter of the cultivable land area continues to lie fallow. Rain water is not harvested and is allowed to go waste causing floods. Judicious use of groundwater is not being practiced. No concerted effort is being made to cover degraded land with tree growth. All these operations require tremendous man power and the guiding hand of science. Key to solve the twin evils of poverty and unemployment is development of agriculture to its fullest potential and converting it into an economically profitable enterprise. In this endeavour Earth Scientists of India have to play their part. Our research activities should have some relevance to the Nation's basic problems. We cannot afford to ignore them.

"Agriculture should be our primary concern whether we are farmers or not. In a real sense, we are all farmers, all of us who eat." Let me conclude with the exhortation of C. V. Raman made more than thirty years ago on the occasion of the Centenary of the Lal-bagh gardens at Bangalore.

"We must be ever prepared to accept and experiment with new materials from all sources and determine what can be useful to us and take the fullest possible advantage of such material. But such work should be done by men of science, familiar alike with the latest advances of theoretical knowledge and of practical techniques . . . . . It is the association and continuous contact with such activities that can revivify our centres of learning and serve to remind them that the aim of science is to advance our knowledge of Nature and by doing so to serve the needs of humanity as well." (C. V. Raman, *Current Science*, v. 26, 1957, p. 304.)

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