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Whither to Pedology and Soil Survey-some Thoughts

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Late Dr S.V. Govindarajan was a towering soil scientist, who besides occupying several important positions in the Department of Agriculture of his home State, provided leadership to the All India Soil and land Use Survey Organisation as its Chief Soil Survey Officer for a decade and prior to that also helped establish one of its then four regional centres, namely the Bangalore Centre. It is in keeping with good traditions of an organisation that the National Bureau of Soil Survey and Land Use Planning, which evolved out of AISLUS, and the Indian Society of Soil Survey and Land Use Planning are fondly remembering their mentor through institution of the Dr S.V. Govindarajan Memorial Lecture. I am indeed privileged by this invitation to deliver the first lecture, which incidentally gives an opportunity to me to pay my own tributes to this outstanding personality.

I have spent a good part of my life in pursuing the discipline of pedology and soil survey though the situations dictated by call of duty engaged me in several other related and un-related activities. The subject has remained dear to me all through and even today, at my advanced age, looking at soil profiles does not tire me. I do not know whether it was a mere coincidence provided by the terrain and the multidisciplinary natural resource survey group that I was working with or a fortuitous trait, I looked at soils not only for their morphology and distribution but also at the possible pathways of soil formation and landscape evolution and in relation to landscape of their occurrence. The approach was exciting and rewarding as a scientist. Therefore, I have chosen pedology and soil survey as the topic of my talk before this distinguished gathering.

But before I come to my talk, it is

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my abounding duty to mention the massive effort that has gone on in the country during the past nearly five decades in soil survey and mapping, particularly of the last one and half decades of the National Soil Mapping Project, that has been implemented by the Bureau in association with other central and state organisations. For the first time the entire country has been soil surveyed at a scale of 1:250,000 with a uniform approach and a common methodology and map legend. The maps and reports of individual states were out few years ago, and now a map for the country on 1:1 million has just been brought out also. The process has yielded also a massive soil database, which should continue to come handy for decades to come. I compliment all those who envisioned, planned, organised and participated in this gigantic effort of national significance.

Now, the thoughts:

Strengthening of soil-landscape relationships

Presence of remnants of laterite crust and a whole range of younger surfaces in much of our peninsular region bespeak several episodes of denudation during the last few million years i.e. Late Tertiary and whole of the Quaternary. The parent material of soils developed on the younger surfaces could be a fresh rock-cut surface or the sediments derived from the pre-existing soils and landforms. The soils developed from these thus could have imprints of past weathering further modified under their new setting. Thus on landscape scale, factually you have an assemblage of soils of varied antiquity and a complex or composite genetic manifestations. Understanding these relationships to my mind holds key to a better understanding of pedogenesis, distribution and classification of these soils. Since, climate has not remained the same during this prolonged period, it is not inconceivable that several of our soils are in fact polygenetic, bearing imprints of the present and past climates. It seems heartening that some of your latest work is showing an increased understanding of this important element.

Even, in the much younger Indo-Gangetic plains, landforms analysis holds a key to fathom soil variations. The division of these plains as active, recent and old flood plains is indeed a significant development. But even within the vast old alluvial plains, recognition of levees, channel bars, fans of various antiquities are significant to proper understanding of soil formation, as indeed is the role and subtle differences in relief. I know from my own experience in arid zone how an appreciation of old and young aeolian and alluvial surfaces, colluvial and sand-covered piedmonts and a variety of pediments provided a better framework for soil-landscape evolution. Dating of several of these landforms and calcretes developed therein has enabled reconstruction of landscape and paleoclimate history. We know now that much of the Quaternary era in the Thar Desert was punctuated by periods of ameliorated climates, when the ground waters

rose high enough to lead to massive accumulation, mainly of calcium carbonate. Lowering of this water table in drier regime caused differentiation of this carbonate in near surface conditions caused exceedingly well-formed nodular calcretes that is so striking a feature of arid zone landscape. These calcretes are in fact a hybrid, where enrichment took place from periodically raised groundwater regimes and subsequent differentiation into nodules occurred under near surface soil processes.

Summing up, in several parts of our country, an improved understanding of pedodgenesis can be explained by landscape evolution and past climate history.

Anthropogenicity in our soils

It has long been known that soils form from an interaction of several state factors, amongst which climate and vegetation are the active ones. All our soils, except the recent ones, ought to have developed and acquired there present degree of zonality by operation of these factors. But another fact is that a vast majority of our soils have been under plough for several centuries, and some possibly for thousands of years. Cultivation means a replacement of the original, natural ecosystem by a cultured system with profound influence on carbon and nutrient cycle and the biota integral to it. The original native cover favoured an immense and intense biomass turnover and supported a large set of miro- and micro-organisms. It is well known that in forested ecosystems, coarse soil porosity attributable to burrowing insects and other organisms contributes as much to water infiltration as the particle size and soil structure-based porosity. Therefore a crop ecosystem means not only a diminution of the organic and nutrient cycles and soil biodiversity, but also a profound effect on hydrological and thermal regimes of soil. Conventional tillage and diminished organic carbon and weakened soil structure promote increased run off and possibly an accelerated clay illuviation. Paddy cultivation, which has spread far beyond its traditional geographic confines, means even more rigorous human intervention. These are besides the more vivid forms of soil degradation like the soil erosion, secondary salinisation and water logging and those due to imbalanced use of fertilizer nutrients and use of pesticides etc.

Therefore, it seems to me that our soils are an outstanding candidate to study the anthropogenic-induced manifestations that are getting imposed on the pre-existing genetic features. Since, the manifestations as neo-formations may still be very weak, several of these may have to be studied at process level. I know some effort in this direction has been initiated, but a lot more needs to be done. Such studies have the potential to form a foundation for establishing the long-term sustainability of our soils and thus address to the growing environmental concerns that dominate the thinking of the present day vocal society. This may provide the subject of pedology the much needed public visibility that is needed in any democratic set up.

Enhancement of the quality of soil database

We have come a long way from the naming of soils of a given area as A, B, C... , arbitrary sampling and a soil description limited to its physical and physico-chemical analysis of the early fifties of last century to a state of art descriptions and analysis. Looking back, I see that a corner stone to our improved mapping and soil identification was the USDA Soil Survey Manual. The concept of soil series, standardized soil profile description and soil mapping procedures enunciated therein have stood the test of time. Since, soil interpretation for conservation, productivity management for our conditions is quite different, we have rightly made our own adaptations and modifications to the USDA approach.

We have today an assemblage of thousands of soil series recognoised during surveys by the central and state organisations. But a correlation of these is sadly lacking. Besides, a pedological basis and a comprehensive charaterisation for micrmorphology, mineralogy and management behavioural aspects need strengthening also.

Equally, appalling is inadequate use of remote sensing tools in soil mapping. These tools provide a vivid and unbiased view of landforms, land cover, soil surface and field moisture variations. Admittedly, landuse and management differences tend to blur this interpretability, but these can be mastered with experience to extract the information of your interest. Once you learn to read the imagery, it becomes impossible to go the field without an imagery in hand. Only care has to be to use imagery of the right season, scale and a rightly composed FCC.

Soil Taxonomy

The USDA Soil Taxonomy is an elaborate, globally applicable, hierarchical system of soil classification with well-defined differentiating criteria based on measurable soil and associated land characteristics. Though not a genetic-based system, several of its higher categories rely on properties that are an outcome of distinct soil forming processes. The beauty of the system lies also in the fact that the nomenclature i.e., name of the taxa itself provides information on several of the genetic and pragmatic properties of a given soil. The system has provision for azonal and intrazonal soils and also somewhat open-ended for inclusion of new soils and concepts and in fact several revisions have appeared from time to time, including the latest of the year 1998. The system has been discussed by scientists of several countries ever since, though several of the European countries have not opted for it partly because of national prided and partly as the these countries found their own well-developed systems more appropriate and meaningful in their given situation. A usual criticism has been that while Taxonomy is moving in its own direction of introducing new concepts and making finer sub-divisions, it is producing a system that is getting increasingly

difficult for understanding and hence use by others than the taxonomist himself. Our country took a conscious decision to adopt this system in year 1969. A huge number of soil series recognized over the years have found their classification using this system. However, the experience has thrown also some problems. Most of these are well known but even then it is worth mentioning these.

Problem of Inceptisols: The order Inceptiols, as rightly pointed out by several investigators earlier also, is a waste-basket group, where all soils that do not fit into one or the other orders get accommodated. As a result a huge number of genetically and morphologically unrelated soils have gone into this order. In our own country, such soil occupy nearly 40 per cent of the area of our country and include soils that earlier belonged to red soils dominated by kaolinitic clay mineralogy, black cotton soils with smectite, soils on Late Quaternary alluvial plains with mixed mineralogy and the periodically wet, mildly acidic soils of Brahmputra valley and so on. Several of our shallow with contrasting morphology are also placed in this order. Not only landform and soil wise, even climatically these soils occur from sub-humid to dry semiarid climes with a vast range in amount of rainfall (550mm to 1500 mm) and hence in the length of crop growing season and crop pattern.

The orders Alfisol and Entisol also suffer from several of these limitations. The system does not do adequate justice to a large extent of salt-affected soils of the country. These soils occur under varied climate and landform settings, from coastal plains, playas to alluvial plains in rainfall regimes of 100 to 1000 mm. The secondary salt-affected soils in irrigation commands are besides. The original premise of looking at the excessive amount of salts as a limitation of usable soil moisture itself is inadequate in fully reflecting the soil limitation due to salts. A soil is considered to have a salic horizon only at very high salt concentrations, where in fact nothing can grow. But we know salt concentrations at much lower level start affecting choice and yield of crops. Absence of a prismatic or columnar structure in our saline-sodic soils militates against their recognition as Natrargids. Besides, there are immense variations in other soil morphological features and nature and amount of profile salt distribution. There are surficially saline, calcareous soils with permeable substrata where a mild leaching and raising of resistant crops for a couple of years can bring about the needed reclamation. The Taxonomy seems grossly inadequate in classification of our salt-affected soils.

It seems to me that to do justice to several of our soils, we shall have to relook at some of the criteria of USDA Taxonomy. The typically monsoon pattern of rainfall of our country creates a situation where large parts of our country with subhumid to drier climate regimes experience dryness for 3-4 months at a stretch. But the amount and distribution of rainfall thereaf-

ter in the arid to sub-humid climate regimes leads to large range in the length of moisture in soil profile and hence in the duration of growing season. The currently existing soil moisture regimes that are used as criteria at order, group and sub-group levels are inadequate to address the situations of a monsoonal country. Therefore, I am of opinion that we need to revise the system to cater to our situations, instead of somehow living with the situation. As far as possible this revision should be done within the guiding principles and concepts of Taxonomy. Failing that, we should modify the criteria and their ranges to meet our requirements.

Land Use Planning

It is indeed curious that historically speaking, land use planning has been both strength and a weakness of soil survey organizations in the country, a paradoxical situation indeed. Strength because no other organization has the detailed information on soils, something, which is considered so basic to new and alternate uses. Weakness because we look at soil and not at land with all its assets and limitations that it is for a farmer. Besides, in a country with miniscule-size holdings and no alternate means of livelihood, a farmer has no option but to make most of whatever he has. Further, it is not just the soil but several other features like availability of supplementary source of irrigation water, access to technology, capital and markets which make all the difference in determining land use. Several of you may be aware of situations where framers with just 20 cm of soil depth but with availability of water are running highly productive systems., They seem to compensate their soil limitation with greater labour input, modifying irrigation regime and using above average plant production inputs. Cultivation on steep slopes in hill regions is another such example.

I know of cases where grass-root organizations working on agricultural development at watershed or village level have found an alternative approach i.e. the participatory resource appraisal, based on felt soil and water management needs highly rewarding. The data inputs that go into their decision system are quite apart from our soil survey-based approach. I believe that a merit in their approach is that they take a holistic view of land than just ther soil that we tend to do. The other reason could be the fact that in several regions of our country, land use is dictated mainly by the existing water supplies and those that can be built up by better rain water harvesting and groundwater recharge. But it may be worthwhile for some of the experienced soil surveyors to look at this alternative approach of participatory resource appraisal in resource use planning and development.

Currently, there is major NATP project on land use planning. This project covers some of the most extensive agro-ecological regions and the best of our manpower and technological inputs have gone into it in a mission-mode. The results of

this and the experiences from varied other sources should throw a valuable light on the scope that land use planning holds for the country.

Thanking you for this valued opportunity and the patient hearing.

This Speaker

Dr. R. P. Dhir, born on May 12, 1935, received his graduation in Agriculture in 1954. An associate of IARI (1956) he was awarded Ph.D. in Pedology from Moscow State University in 1965. Dr. Dhir started his scientific carrier as Soil Surveyor at IARI, Ministry of Agriculture from January 1957 and then Pool Scientist under CSIR (from September 1965 to May, 1967). He served as Soil Chemist at IARI (1967-69) and then moved to CAZRI, Jodhpur as Scientist S-2 and became Head, Division of Basic Resources Survey. On deputation, he served as Head, RRSC, Jodhpur and then he occupied the chair of Director, CAZRI, Jodhpur and served from August 1994 to 31st May, 1995.

Dr. Dhir has worked as Principal Investigator in many nationally and internationally funded project and as Consultant with WINROCK at Bangalore and OXFAM at Ahmedabad. He has served as RAC and QRT Members in ICAR. He has 152 research articles to his credit, published in serveral reputed national and international journals. Besides, he has 23 technical reports, 3 popular articles, one book and one bulletin to his credit.

His area of specialization includes natural resource survey including quaternary continental deposits and paleo-environmental interpretations, remote sensing, taxonomy of soils, salinity and use of saline water, desertification, *etc.*

Dr. Dhir was Vice-Presidents of Indian Society of Remote Sensing and (its Chairman for Jodhpur Chapter), Clay Mineral Society of India. He was President of Jodhpur Chapter of Indian Society of Soil Science, Editor (Eco Sci.)of Annals of Arid Zone and member of Organising Committee and Tour Committee of International Congress of Soil Science (1979-82).

Dr. Dhir has attended International Seminars held in Mauritania, China *etc.* He visited Australia in 1974 as Colombo Plan Fellow, and as member of Expert Group visited USA, Israel, USSR and other countries.

Dr. Dhir is a recipient of the Fellowship of the Indian Society of Soil Science in 1990.

This Lecture

This lecture is being organized by Indian Society of soil Survey and Land Use Planning at NBSS&LUP, Nagpur.

A short life sketch of Dr. S. V. Govindarajan and his achievements is given here.

Dr. S. V. Govindarajan was born on 28th August, 1913 in a distinguished family of lawyers. He had his graduation and post-graduation at Presidency College, Madras during 1930-34. He joined Indian Institute of Science, Bangalore in 1935 as Scholar and later in 1936 joined Royal College of science, London, U.K. wherefrom

he obtained Ph.D. in Soil Science in 1938. In 1939, he returned to India and joined Agricultural Chemistry Division in the Department of Agriculture in the erstwhile Mysore State. Between 1943 and 1946, he worked as Bio-chemist in the scheme of composting and organic manuring and later he was elevated to the position of Agricultural Chemist in 1946. In 1956, he joined as a Soil-Correlator of southern region and again in 1961 as the Chief Soil Survey Officer of the All India Soil and Land Use Survey Organisation.

Dr. Govindarajan served as an Advisory Board Member of FAO/UNESCO Project on soil map of the world, and as a Member of the Advisory Panel on the International Society of Soil Science for establishment of the International Soil Muesum in the Netherlands, between 1962 and 1971. During his four-and a half decades of professional carrier, he contributed immensely in the areas of field soil survey, and fertility research and teaching. Over a dozen research scholars received their master and doctoral degrees under the guidance of Dr. Govindarajan. He compiled a soil map of India in the scale of 1:7 million in 1971, on the occasion of the International Symposium on Soil Fertility Evaluation held at New Delhi. He built up the short term soil survey training facilities at Nagpur and BAngalore in the techniques of standard soil survey, classification and mapping the soils. Besides, numerous soil survey and land use classification reports, he published over 80 technical and scientific papers and two books. After superannuation in 1971, he continued research activities as Emeritus Scientist upto 1976. In the following years, he worked as Advisor with Agricultural Scientist Recruitment Board; State Bank of Mysore; and Nagarjuna Fertilizers and Chemicals Ltd. In the last few years, he was appointed as Chairman of the Review Committee by ICAR.