SURESH KUMAR SINHA

(1934-2002)

Elected Fellow 1983

Indian Agriculture suffered a serious loss at the sudden and untimely demise of Dr SK Sinha one of the brightest and analytical agricultural scientists of the country. Although he is no longer with us, his work stands as enduring mark of his intellectual acumen and organisational ability.

BIRTH, EARLY LIFE AND EDUCATION

Professor Suresh Kumar Sinha was born on 18th July, 1934 in an average family in a village in Bulandshahar, UP, India. He lost his mother when he was seven years old. His father, a Manager in a Zamindari (Estate) wanted his two sons to get education, hence he was admitted to a primary village school. He then went to an intermediate college in the district and lived in a hostel from 4th standard, until he did MSc (Botany) in 1957 from Agra College, Agra. His education in a small town and subsequently in Agra College instilled traditional values and respect for teachers. Thus he believed that his growth in science was the result of the impact of his teachers, formal and informal with whom he came in contact with. He passed matriculation with Geography, Economics and Mathematics. Having obtained a distinction in Mathematics he was allowed to become a science student.

Finally he did MSc (Botany) with a first class and a thesis in plant physiology, which helped him to become a Lecturer in DAV College, Kanpur from 1957-62 and provided an opportunity to interact with scientists at Agriculture College, Kanpur where he worked for a PhD degree in Plant Nutrition in 1962. While working, he specialized in Genetics and Plant Breeding also. However, this was the period when the use of radioisotopes, particularly of C^{14} appeared very fascinating. *i.e.* how one finds out the movement of label within a molecule and between molecules. This motivated him to go to do a second PhD in plant biochemistry at the University of Alberta, Edmonton, Canada from 1962-64. Exposure at the University of Alberta was extremely rewarding. He published a paper in *Nature* on radio-sulphate metabolism within six months of joining as a PhD student. This gave him confidence and subsequently a series of papers were published on amino-acid biosynthesis, and the importance of C1 compounds, in international journals of repute. His outstanding work on glycine-serine conversion in plants is part of text books in plant biochemistry. He obtained PhD in a record time of 19 months, but continued as a Post-Doctoral Fellow for another year (1964-1965) in the same department.

PROFESSIONAL CAREER

Returning home Professor Sinha joined the CSIR Scientists Pool for a short period, and later on, joined as Plant Physiologist at the Central Tuber Crops Research Institute, Trivandrum in 1966. This was a new Institute and except for a room in a hired building where the Institute was located nothing else was available. The occurrence of cyanogenic glucosides in Cassava was an important and challenging problem. To estimate cyanide initially, a titration method was developed by Dr Sinha followed by a calorimetric method when an Indian made colorimeter could be bought. He identified cassava varieties with low cyanogenic glucoside content in the tubers. This was significant contribution as cassava is an important crop for poor people in South India. Dr Sinha combined the knowledge of botany with plant physiology and biochemistry in working out the mechanism of tuberization and tuber development. Using simple tools he linked starch deposition with tuber development. These were new findings for this crop and are included in books on tuber crops. He further showed that cyanogenic glucoside content could be regulated by foliar application of urea under high fertility conditions.

Professor Sinha came to Indian Agricultural Research Institute in 1969 and joined the Division of Plant Physiology as Plant Physiologist. He, along with his students, initiated work on photosynthesis rate in relation to productivity. Photosynthesis rate was measured by a simple indigenously designed set-up measuring the incorporation of $14CO_2$ using labelled bicarbonate. In fact, this was the initiation of studies on carbon assimilation pertaining to the genetic variability, developmental effects and source sink relationship in important agricultural crops including legumes and cereals in India. Internationally also, there was emphasis on understanding the factors regulating the photosynthesis rate, biomass accumulation and productivity in C3 and C4 plants. Studies on photosynthetic enzymes Rubisco (ribulose 1-5 biscarboxylase) and PEP (Phosphoenol carboxylase) were also conducted in both vegetative and reproductive parts of crops to understand their contribution to crop yield. C4 plants have been identified as superior to C3 plants and differences between C3 and C4 plants at the anatomical, physiological and biochemical level were being elucidated. Professor Sinha's studies on photosynthetic enzymes in the leaves of C4 plants in the post anthesis phase clearly showed that C4 pathway was developmentally regulated. The leaves during senescence exhibited a change from C4 to C3 pathway. This was a significant contribution and was published in Biochemical and Biophysical Research Communication in 1973. These results were subsequently confirmed in other laboratories and are quoted profusely in the literature.

Another significant contribution made by Professor Sinha and his group was the revelation that developing reproductive parts of crops such as brassica, wheat, pea, chickpea etc. have high activity of photosynthetic enzymes *i.e.* PEP carboxylase and thus have high potential for carbon assimilation on unit chlorophyll basis. These were new findings and were published in national and international journals of repute.

Professor Sinha also initiated studies on the mechanism of heterosis, a phenomenon which has contributed significantly in increasing agricultural productivity. The basic question addressed was to answer as to why an F1 plant grows and yields better than its parents in the same environment? In a sense, it addressed the question of the physiological basis of the yield using related genetic material as against all earlier work which was based on usually genetically unrelated varieties. Using hetrotic hybrids of maize, sorghum and their parents, his group conducted studies on various aspects of metabolism to understand the basis of seedling vigour and finally leading to hetrosis in yield and yield components. A new hypothesis was proposed to explain the phenomenon of heterosis and its various components *i.e.* hybrid vigour, homeo stasis, inbreeding depression, general and specific combining ability. The hypothesis was based on dominance/partial dominance at component level and combined with a complementary and multiplicative relationship giving an expression of over dominance at the whole plant level. This review was published in Advances in Agronomy in 1975. This was subsequently validated by others and is part of text books on genetics and plant breeding. The hypothesis gave direction to heterosis breeding as well as selection of genotypes in segregating population. It was predicted that heterosis breeding in rice and wheat may not be as advantageous as in maize and sorghum. This was observed to be true by rice breeders, Dr SS Virmani at International Rice Research Institute, Manila, Philippines breeding for hybrid rice. Professor Sinha always considered this review as the most significant achievement of his lifetime as it integrated his understanding of yield and yield related processes from cellular to whole plant and finally community level.

Professor Sinha joined as Senior Plant Physiologist at Water Technology Centre, a new multidisciplinary department established in IARI, New Delhi in 1972. He was placed incharge of the Dryland Research Project Centre having its headquarters at Hyderabad. He interacted with scientists from other disciplines *i.e.* Engineers, Soil scientists, Entomologists, Agronomists and Agricultural Economists, all working with a single aim of increasing agricultural productivity per unit of available water. He initiated experiments on the response of crops such as wheat and pulses to water variable environment. Then came the realization that water relations need to be defined using the modern technology of water potential rather than water content. He organized a workshop in which he invited Dr Ted Hsiao from University of California, USA to impart training to Indian scientists on water stress quantification, both in terms of theoretical concepts and practical measurement. Plant Physiologists were exposed to equipments used in the measurement of water potential such as Pressure Chamber, Thermocouple Psychrometer and Osmometer etc. So a strong base was laid for abiotic stress physiology research in India, specifically in drought stress, since drought and limited irrigation are important problems in our country.

In 1978, Professor Sinha was awarded Professor of Eminence project by ICAR to establish centre of excellence on abiotic stress physiology which was a recognition of

his outstanding abilities to conduct research in plant physiology. He was assisted in this endeavour by four young plant physiologists, namely Dr PK Agrawal, Dr GS Chaturvedi, Dr KR Koundal and Dr Renu Khanna-Chopra. Long term experiments extending to five years in wheat led to an understanding of the proper requirement of water in relation to soil moisture and winter rainfall. Consequently the recommendation of 5 to 6 irrigations to wheat in North India could be brought down to 2 to 3. The concept of drought resistance was analysed at the physiological and biochemical level. That pulses and oilseeds differ from wheat in response to increasing irrigations was also established. These and other observations in relation to water availability and yield response were summed up in an exhaustive review in "Advances in Irrigation" entitled "Irrigation in India: Physiological and phenological approach to water management in grain crops". This review highlighted the fact that release of canal water for irrigation of grain crops was not in consonance with water requirement of crops at different developmental stages and hence did not result in optimum use of a precious resource *i.e.* water.

Through a detailed analysis of physiological and biochemical criteria, the causes of poor yield in pulses were identified and a new method of selection was introduced. This work also resulted in an FAO book on "Distribution, adaptation and biology of yield of grain Legumes." Professor Sinha was an original thinker and always delved in new areas of research. Water stressed plants were known to have higher temperatures than irrigated plants and this was attributed to the loss in cooling due to inhibition of transpiration as a result of stomatal closure. He and his students initiated studies to show that water stress induced changed in respiratory metabolism i.e. enhanced occurrence of cyanide resistant pathway also contributed towards increase in temperature in water stressed leaf and during ripening in mango and banana. An off shoot of this research was his interest on the biophysical basis of root-shoot communication in water stressed plants of sunflower wherein he showed the involvement of membrane potential as the possible signal from stressed root to the leaf much before any change in water relations occurred. This was accompanied by change in the leaf stomatal conductance.

In recent years, Professor Sinha was involved in the area of Climate Change. He analyzed the potential effects of Climate Change (combined effects of CO_2, temperature, radiation and precipitation) on Indian Agriculture and of developing countries. He and his colleagues showed that rice paddies are not a major source of methane. Estimates based on carbon source requirement showed only 10 to 12 Tg global methane production, which was much lower than reported internationally for India.

He started a 'Plant Biochemical Society' in 1974, which published "The Plant Biochemical Journal" and held symposia to promote biochemical research in plants. Subsequently, the society was re-named the 'Society for Plant Physiology and Biochemistry' and the journal, the Journal of Plant Biology. Sinha also organized an

International Congress of Plant Physiology in 1988, which was attended by 200 eminent scientists from abroad. He compiled a book entitled Classical Papers of Plant Physiology, including the works of eminent scientists like JC Bose, Dastur and others, and got it released at the congress.

AWARDS AND HONOURS

Professor Sinha continued as Professor of Eminence from 1978-91 and as National Professor from 1995 to 1999, a period which was very rewarding professionally. He received several awards for his contribution to agricultural science namely:

- 2000: Jawahar Lal Nehru Birth Centenary Award, Indian Science Congress Association
- 1999: K Ramiah Medal, National Academy of Agricultural Sciences, Delhi
- 1999: Lal Bahadur Shastri Memorial Lecture: Indian Agricultural Research Institute
- 1999: BP Pal Memorial Lecture: National Academy of Science, Allahabad
- 1993: Jawahar Lal Nehru Birth Centenary Lecture Award of Indian National Science Academy for Plant Science
- 1993: Sunder Lal Hora Medal of Indian National Science Academy for Plant and Animal Science
- 1992: Fuel Instrument and Engineers Foundation Award
- 1991: Jawahar Lal Nehru Fellowship
- 1989: Birbal Sahni Medal, Indian Botanical Society
- 1988: OP Bhasin Award for Research in Agricultural Science
- 1985: VASVIK Award for Research in Agricultural Science
- 1984: SM Sircar Memorial Award, Bengal Botanical Society
- 1983: Federation of Indian Chambers of Commerce and Industry Award for Agricultural Research
- 1979: JJ Chinoy Gold Medal, Indian Society of Plant Physiology

He was Fellows of many prestigious societies of our country such as : Indian National Science Academy; Indian Academy of Science; National Academy of Sciences; National Academy of Agricultural Sciences and Indian Society of Genetics and Plant Breeding.

He provided professional service as part of Editorial Board of leading national and international journals such as: Journal of Agricultural Sciences (Cambridge

University Press); Field Crops Research, Elsevier (Netherlands); Climatic Change-Elsevier (Netherlands); Journal of Science & Technology (CSIR Delhi) and Environmental conservation (Cambridge University Press).

He also held important positions in societies such as President : Agriculture Section, Indian Science Congress Association (1986-87); President: Agriculture Society of India (1986); Secretary General: International Congress of Plant Physiology (1988); Secretary: National Academy of Agricultural Sciences; Secretary: Society for Plant Physiology & Biochemistry; Secretary General: 2nd International Crop Science Congress 1994-96 and President: Society for Plant Physiology & Biochemistry.

Professor Sinha was a recognized supervisor of several universities. He guided 15 students for PhD and 3 for MSc thesis respectively. A teacher is often recognized by the achievements of his students. Four of his students namely:- Dr R Khanna-Chopra, Dr PK Aggarwal, Dr Anil Grover and Dr Sanjay Kumar were INSA Young Scientist awardees.

SPECIAL ASSIGNMENTS

Chairman: Xth Five-year Plan Working Group on Agriculture Research and Education (Indian Council of Agricultural Research, New Delhi) set up by Planning Commission, Govt. of India.

INTERNATIONAL

(1) Consultant, FAO Rome, to write a book on the Distribution, Adaptability and the Biology of yield of Food Legumes, 1975-76. (2) Member, Advisory Committee on Physiology and Biochemistry of drought resistance in plants, International Development Research Centre (IDRC), Canada, 1974-1979. (3) Alf Hannaford Fellow (Visiting Professor), Waite Agricultural Research Institute, The University of Adelaide, Australia, December 1976 to June 1977. (4) Consultant for FAO/Danish International Development Agency Course of "Food Legumes" held at Tehran,1975. (5) Member, World Meteorology Organization Committee which issued a statement on Carbon Dioxide and Climate on behalf WMO, 1980. (6) Member, Scientific Advisory Committee, "Climate Impact Program" United Nations Environmental Program, Nairobi, 1982-1986. (7) Member, World Meteorology Organization for organizing Second World Climate Conference, 1990. (8) Member, Programme Advisory Committee, First International Crop Science Congress, 1992. (9) Member, Scientific Advisory Committee, International Geosphere Biosphere Program, 1990-1992. (10) Member, Review Committee, CIMMYT Crop Management and Plant Physiology Program, Mexico. (11) Co-Chairman, Agriculture & Forestry Section, Inter-Governmental Panel on Climate Change Working Group-II, World Meteorology Organization. (12) Invited Speaker on Global Warming and Agriculture, Second World Climate Conference, Geneva.

(13) Chairman Steering Committee, IDRC Project "Diversity for Farmers Use"
(14) Review Editor, IPCC Third Assessment Report- Synthesis Chapter.

NATIONAL

He was member of several scientific panels involved in reviewing and funding of scientific projects in plant physiology, biochemistry and agriculture. He was Member of governing body of several universities. He was chairman research council of CSIR complex Palampur, CIMAP and NBRI, Lucknow. He was member, Technology Development Board, Govt. of India. (1) Member, Scientific Panel on Physiology and Biochemistry, Indian Council of Agricultural Research, New Delhi. (2) Reviewer of Research Projects for Indian Council of Agricultural Research, Council of Scientific and Industrial Research, University Grant Commission and other organizations. (3) Member, Environment Research Committee, Department of Environment, New Delhi. (4) Member Plant Physiology and Biochemistry Panel Department of Science and Technology, New Delhi. (5) Member Bioscience Panel, Universtiy Grant Commission, New Delhi. (6) Member, Indian Council of Agricultural Research Team for National agricultural Research Project in Andhra Pradesh Agricultural University, Tamil Nadu Agricultural Universtiy and Udaipur University. (7) Member Indian Council of Agricultural Research Quinquennial Review Team for Central Rice Research Institute, Cuttack, and the All India Coordinated Rice Research Project, Hyderabad. (8) Member Governing Body, GB Pant Himalayan Institute of Environment & Development. (9) Chairman, Scientific Advisory Committee, GB Pant Himalayan Institute of Environment & Development. (10) Chairman, Research Council of CSIR Complex Plampur, Central Institute of Medical and Aromatic Plants and National Botanical Research Institute, Lucknow. (11) Member, Academic Council, Jawahar Lal Nehru University, New Delhi. (12) Chairman, Panel on Agriculture-2020 Technology & Information Forecast and Assessment Council, Govt. of India 1995-96. (13) Member, Technology Development Board, Govt. of India. (14) President, Centre for Environment, Agriculture Development. (15) Member, Peoples Commission on TRIPS, New Delhi. (16) Member, Governing Body of Management, UP Agriculture University, Pantnagar.

DIRECTOR, IARI

Professor Sinha was the Director of Indian Agricultural Research Institute, New Delhi, the premier agricultural Institution of the country from 1991 to 1994 and retired in the same capacity. He brought significant organisational changes during his regime. He believed that decentralization of power improves scientific administration. So he increased the sanctioning power of the Heads of Divisions of IARI from Rs.20,000/- to Rs.50,000/-. He also simplified the procedure for the purchase of equipments which was headed by a committee having Jt. Director (Research) as the chairman and had representatives from stores, finance, audit and senior scientists from various disciplines

as members. This cut short the red tapism, hastened the purchase process and thus enabled the purchase of equipments to be completed within shortest possible time. In fact this procedure was appreciated by the CAG, India (personal communication).

Professor Sinha was a teacher at heart and had great love for education. He had very good rapport with students. He taught several courses to students of plant physiology and his favourite topics were plant metabolism and stress physiology. As Director, IARI he gave a one time grant of Rs.50,000/- to Professors of various disciplines to develop the post-graduate laboratories for students. Although not an Almamater of IARI, he loved IARI, as he spent a greater part of his scientific career here. He devised new ways to improve the outreach programmes of IARI, which helped in improving agricultural productivity in various parts of the country. Thus when wheat crop was devastated in Uttarkashi and surrounding villages in Uttranchal due to severe earthquake he requested IARI staff to contribute one day's salary toward 'Uttarkashi fund' which was aptly utilized to provide seeds of high yielding wheat varieties and winter vegetables to farmers of earthquake affected area. In addition farmers were trained in growing nurseries of high yielding varieties of summer vegetables in order to empower them to earn more and be self reliant. IARI also helped in Kenu plantations in that area. Under his leadership dynamic and devoted IARI team did wonders. Farmers got 4 to 5 times higher yields and the manner in which hundreds of villagers welcomed IARI team was a sight for which IARI felt proud. Similarly IARI took up project to multiply seeds of high yielding wheat varieties recommended for North Eastern region of the country in Sone Command Area of Bihar which helped in the spread of IARI released wheat varieties in that region of the country and gave IARI fame and monetary returns.

IARI Library is still the largest national agricultural referral Centre and indeed needed a fresh look. He took initiative and completely renovated the reading halls, display of latest journals and books, computerized it completely with state of art facilities linking it with various divisions and provided ultra modern facilities for students and staff and for visiting scholars across the country. The present set up has become the role model for other SAU's and ICAR institutes.

He took bold and unconventional decisions at times, e.g. privatization of IARI security and maintenance of various guest houses and students hostels by ex-army personnel through Defence Ministry's Department of Rehabilitation. This example was later followed by other ICAR institutes.

Professor Sinha played a key role in setting up of Phytotron as National Faculty at IARI by Department of Science and Technology with UNDP assistance. In this endeavour he was helped by eminent plant physiologists, Dr SC Bhargava and Dr PV Sane. Professor Sinha had the vision, patience and perseverance in convincing the

scientific departments to establish this state of art facility which is useful for scientific community and students of India and neighbouring countries.

PERSONAL QUALITIES

Professor Sinha was a kind, warm-hearted simple person and believed in the inherent goodness of mankind. He was broadminded and open to change. He was a true statesman. His major concern was food and nutritional security for burgeoning population of India. In his own words "A country of the size and natural resources such as ours should not become dependent on anyone for food as it demoralizes not only individuals but also the nation. A society that becomes dependent on others for food cannot defend itself. For him the main challenge was to achieve food security including the nutrition through our own agricultural production as India is endowed with a number of agroclimates which can support production of almost all crops including grains, vegetables, fruits etc. Professor Sinha was an endearing person and used to care for his colleagues and coworkers.

THE LAST PHASE

Professor Sinha was keenly interested in the futuristic studies. He used to analyse the food and nutrition requirements of India in the coming decades and the capacity of the country to produce the same with its own resources. Vision –2020 in food and agriculture prepared for TIFAC encompassed this analysis and identified Eastern UP, Bihar, Orissa, Eastern MP, West Bengal, North eastern India and Uttranchal as regions with low productivity despite high productivity potential. Professor Sinha had a desire to utilize the knowledge available in agricultural science for the benefit of farmers. This prompted him to establish a Centre for Environment, Agriculture and Development (CEAD) in 1993 which had a major objective to render help, guide and advise on scientific methods in agriculture, approaches to protect the environment and to initiate a process of development. With the financial assistance provided by TIFAC, Sinha initiated agricultural developmental projects in Bihar, Eastern UP, Orissa, Kanjipuram, Pinder Valley, Uttaranchal and Sikkim, so that Vision 2020 could become a mission and reality. He had the support of Abdul Kalam, then Chairman TIFAC and Principal Scientific Advisor, Government of India. His endeavours resulted in increased productivity of wheat and rice, and motivated the farmers to diversify the cropping system by including pulses, oilseeds and vegetables in their cultivation.

He visited the project sites, conducted meetings under the trees at the outskirts of villages and loved sharing eatables with farmers and teammates. He used to prefer organising meetings at houses of under privileged people to enhance the social and communal harmony in the villages. His field visits motivated the educated village

youth to get involved in agricultural operations in their own land. Professor Sinha suddenly expired on 17th March, 2002 and left behind his wife and three married daughters who are pursuing their professional careers.

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