

**LAKSHMINARAYANAPURAM ANANTHAKRISHNAIYER
RAMDAS
(1900-1979)**

Elected F.N.I. 1935

LAKSHMINARAYANAPURAM ANANTHAKRISHNAIYER RAMDAS, the pioneer of modern Agricultural Meteorology in India was born in a Brahmin family in Palghat in the Kerala State on June 3, 1900. His father, Professor L. K. Ananthakrishna Iyer was a renowned anthropologist and an ethnologist who made penetrating studies of the Tribes and Castes of Kerala and Mysore.

EDUCATION & RESEARCH

Ramdas took his B.A. degree from the Presidency College, Madras in 1920. The following year, he went to Calcutta where his father was Professor of Anthropology in the University. Their residence was close to that of Professor C. V. Raman and just behind 210, Bowbazar Street, the then headquarters of the Indian Association for the Cultivation of Science. Under the inspiring guidance of Professor Raman, the Indian Association had become an active centre of Research in many branches of Physics and attracted research workers from different parts of India. Professor Raman was also the Palit Professor of Physics in the University College, Calcutta, where he gave regular courses of lectures to post-graduate students working for their M.Sc. and Ph.D. degrees.

Ramdas along with his friend K. S. Krishnan regularly attended these lectures, moved about in the Association, meeting the scientists working in the Laboratory and became familiar with the problems on which they were working. Ramdas took the M.A. degree of the Calcutta University in 1923, and shortly after, obtained a Palit scholarship to work in the Association laboratory.

While his friends, K. S. Krishnan and S. Venkateswaran were working on problems of the volume scattering of light by various liquids and vapours, Professor Raman asked Ramdas to turn his attention to the study of the surface scattering of light by liquids and solids. A large number of liquids like water, organic liquids, mercury and liquid carbon dioxide at different temperatures and pressures were studied. The scattering of light by the liquid surfaces was explained as being due to molecular bombardment of the surfaces by the overlying molecules of air or vapour. The results of these studies were published in 1925 in a series of three papers by the Royal Society, London, by Professor Raman and





R.Ramdas



Ramdas, on "The scattering of light by liquid boundaries and its relation to surface tension" These and other allied studies gained for Ramdas the Ph.D. degree of the Calcutta University in 1927.

PROFESSIONAL CAREER & CONTRIBUTIONS

In 1926, Ramdas joined the India Meteorological Department as an Assistant Meteorologist and was posted to the Meteorological Office, Karachi, where he gained experience in the growing field of Aviation Meteorology.

In 1930, Dr Ramdas was transferred to the Poona Meteorological Office. Besides doing his regular duties, Ramdas found the environment congenial for starting work on the physical problems of ground-atmosphere interface. In collaboration with S. L. Malurkar and S. Atmanathan, he made measurements on the changes occurring in the temperature and moisture content of air layers close to the ground, upto a height of about 10ft, from early morning to late afternoon hours. They discovered that just above the heated land there were narrow jets of rising hot air alternating with broader areas of descending cold air.

In 1931, on the initiative of the Imperial Council of Agricultural Research (ICAR), a Research Section on Agricultural Meteorology was created in the Meteorological Office, Poona, to study "Weather in relation to Crops" and Dr Ramdas was appointed Meteorologist-in-charge of the Section. Funds for starting and maintenance of the Agricultural Meteorology Section were provided by ICAR.

With the co-operation of the authorities of the Poona Agricultural College, plans were made for setting up an Agri-Met Observatory on the grounds of the College. The College authorities provided 1/4 acre in the middle of their farm area for the observatory. Starting with a few basic meteorological instruments, new equipment was acquired or built and installed, and regular observations were started and systematically analysed. The college authorities, the India Meteorological Department and ICAR, took keen interest in the work. It was arranged that *annual reports* of the work of the Section be sent to ICAR, who reviewed the work and communicated the results to the Agricultural Organisations in different parts of the country.

The Agri-Met Section started with a staff of 12 including 3 scientists with Dr Ramdas as Director, and 6 scientific assistants and observers. In 1940, a Planning Branch was added with a staff of 13 members for building up liaison activities with agricultural farms and for organizing a "Weather Service for the Farmer." Between 1945 and 1947, the staff was increased by another 26 to work the fully planned "Co-ordinated Crop-Weather Scheme" of ICAR. The work done by the staff and students of the Agricultural Meteorology Section between 1932 and 1948 was summarised in the following two publications by Dr Ramdas:

1. The progress of Agricultural Meteorology in India during 1932-48; and
2. Dr Ramdas's Presidential Address to the Physics Section of the Indian Science Congress—Patna 1948. "The Physics of the bottom layers of the Atmosphere."



During this period, 158 original papers and 47 reports were published by the staff and research students of the Agricultural Meteorology Section. The scientific papers were on the following topics :—

- (i) Meteorology—General.
- (ii) Micro-Meteorology and related topics. Development of Instruments.
- (iii) Radiation : Solar radiation, radiation from night sky, nocturnal cooling, frost, etc.
- (iv) Physics and particularly soil physics; including soil temperature, moisture, movement of salts, soil swelling, etc.
- (v) Problems of Plant Physiology in relation to meteorological factors.
- (vi) Statistical : Crop-Weather Relationships and Analysis of meteorological data having a bearing on the principal crops grown in different parts of the country.

In 1948, the ICAR made the following comments on the work done by the Agricultural Meteorology Section : “*The Committee was highly impressed with the high quality of the work conducted, and particularly wanted to place on record its high appreciation of the work done by Dr Ramdas, Director for evolving and organising the Scheme (Co-ordinated Crop-Weather Scheme). It was a matter of particular gratification for India that the Indian Crop-Weather Scheme as approved by ICAR has been adopted by the International Commission of Agricultural Meteorology at its meeting held in Toronto in August-September, 1947.*”

It may be mentioned that in 1946, Dr Ramdas was awarded M.B.E. by the Government of India (British). The Co-ordinated Crop-Weather Scheme was taken over by the India Meteorological Department of the Government of India on a permanent basis in April 1949.

From 1948 onwards, Dr Ramdas and his collaborators in the Agricultural Meteorology Section continued to work on the Hydrology of arid and semi-arid tracts of India like Rajasthan and parts of Peninsular India, on convective phenomena over heated surfaces, on solar and wind energy in India, on evaporation from lakes and ponds and their control, and general problems of meteorology and micro-meteorology. In 1953, Dr Ramdas became Deputy Director-General of Observatories (Climatology and Geophysics). He retired from the India Meteorological Department in 1956.

In December of the same year (1956), Dr Ramdas joined the National Physical Laboratory as Assistant Director, in-charge of Heat and Power Division, and continued in that capacity till 1960–61. His active interest in problems of Weather and Crops, Control of Evaporation, Solar Terrestrial Radiations, Thermal balance at the earth's surface etc. continued.

Dr Ramdas was appointed Member of the UNESCO Advisory Committee for Arid Zone Research in 1958. He attended and took part in the annual meetings of the Committee which were held at Teheran (1958), Madrid (1959), Paris (1960), Rome (1961), Tashkent (1971), and Jodhpur (1972). He was able to arrange for UNESCO Aid to the Desert Research Institute at Jodhpur.



HONOURS

In 1958, the President of India honoured L. A. Ramdas with a *Padma Shri*. In 1965, the President, CSIR, appointed Ramdas as "Emeritus Scientist" with freedom to work in the National Physical Laboratory. He occupied a room in one of the upper levels of the tower of the Laboratory and continued to make laboratory studies on Thermal repulsion properties of various types of soils etc.

FOREIGN VISITS AND OTHER DISTINCTIONS

The following is a brief summary of Dr L. A. Ramdas's visits abroad to attend International Scientific Conference and Special Meetings.

1951	Brussels	IUGG Assembly.
1953	Paris	WHO Commission on Agricultural Meteorology.
1954	Perth	Pan-Indian Ocean Science Congress.
1956	Canberra	UNESCO Symposium on Climatology and Micro-Meteorology.
1957	Bangkok	Pacific Science Congress : Dr Ramdas suggested the term Bio-Meteorology which has a broader significance than <i>Agricultural Meteorology</i> .
1961	Rome	U. N Conference on New Energy Sources.
1964	Leningrad	International Radiation Conference organised by IUGG and WMO.
1966	Lebanon	International Bio-Meteorology Conference.
1968	Bergen	Symposium on Radiation (IUGG and WMO)

In the autumn of 1960, Dr Ramdas was invited as a Foreign Visiting Scientist under the joint programme of the National Science Foundation of USA and the American Meteorological Society. He delivered courses of lectures on the Environmental Problems (on which he and his collaborators had worked) at a number of Universities and other Scientific Institutions and held discussions with the Faculty members and Research Scholars. The lectures and discussions were greatly appreciated.

In 1961, Dr Ramdas was invited to participate in a "Ten Year Planning Conference on the Atmospheric Sciences" held at Boston under the Chairmanship of Dr Sverre Pettersen. The Conference lasted six weeks—man's ability to control the atmospheric circulation and atmospheric phenomena came in for special attention. The plans evolved for the ten-year programme envisaged an outlay of 500 million U. S. Dollars.

The scientific academies and societies in India and abroad of which Dr L. A. Ramdas was a Fellow or Member are enlisted below :—

- | | | |
|---|-------------------|------|
| 1. Indian Academy of Sciences, Bangalore | Foundation Fellow | 1935 |
| 2. Indian National Science Academy, Delhi | Fellow | 1935 |



3. National Academy of Sciences, Allahabad	Fellow	1948
4. Indian Meteorological Society	Fellow	1948
5. Royal Meteorological Society, London	Fellow	1936
6. American Meteorological Society	Professional Member	1961
7. World Academy of Arts and Sciences	Fellow	1963
8. Indian Geophysical Union	Fellow	1967

DEATH

Dr Ramdas's health began to fail in the last few months of 1978 and he passed away peacefully on the afternoon of January 1, 1979, leaving his wife, two sons and three daughters.

ACKNOWLEDGEMENT

The author wishes to express his thanks to Dr A. R. Verma, Director of National Physical Laboratory, New Delhi, for giving information about Dr Ramdas's work in National Physical Laboratory during 1956-60 as an Assistant Director, and later as Emeritus Scientist during 1965-70. Thanks are also due to Dr L. A. Ramdas's son Professor A. K. Ramdas, who supplied him copies of notes which Dr Ramdas himself had kept of his life and work.

K. R. RAMANATHAN

BIBLIOGRAPHY

1923. Colours of chlorate of potash. *Proc. Indian Assoc. Cult. Sci.*, **8**, 231.
1924. The scattering of light by solid surfaces. *Proc. Indian Assoc. Cult. Sci.*, **9**, 129.
1925. (With SIR RAMAN, C. V.) The scattering of light by liquid boundaries and its relation to surface tension. *Proc. R. Soc.*, Part I, **108A**, 561.; Part-II, **109**, 150-156; Part-III, **109**, 272-279.
- The spectrum of potassium excited during its spontaneous combustion in chlorine. *Nature*, **4**, 11.
1926. The scattering of light by sputtered metallic surfaces. *Proc. Indian Assoc. Cult. Sci.*, **9**, 323.
- The origin of the movements of camphor on water and other allied phenomena. *Indian J. Phys.*, **1**, 1.
- The scattering of light by gaseous mixtures at high pressures. *Phys. Rev.*, **28**, 1030.
1927. The scattering of light by liquid surfaces. *Indian J. Phys.*, **1**, 199.
- (With SIR RAMAN, C. V.) On the thickness of the optical transition layer in liquid surfaces. *Phil. Mag.*, **3**, 1.
- Influence of climate on agriculture. *Proc. Pun. Edu. Conf. Exhi.*, **427**.
1928. The Raman Effect in gases and vapours. *Indian J. Phys.*, **3**, 131.
- The Raman Effect and the spectrum of the zodiacal light. *Nature*, July 14.
- The spectrum of potassium excited during its spontaneous combination in chlorine. *Indian J. Phys.*, **3**, 31.
1931. (With VENKITESHWARAN, S. P.) The spectrum of the glow worm. *Nature*, October, 24.



1932. A simple method of calculating the roughness of pure liquid surfaces due to molecular agitation. *Indian Sci. Congr.*
- The sea breeze at Karachi. *Sci. Notes, India met. Dept.*, 4 (41).
 - (With ATMANATHAN, S. A.) The vertical distribution of air temperature near the ground during the night. *Gerlands Beitr, Surv. Geophys.*, 37, 116.
 - (With ATMANATHAN, S. A.) A note on fog or haze at Poona during the cold season. *Sci. Notes, India met. Dept.*, 5 (54).
1933. Agricultural meteorology. *Curr. Sci.*, 1, 7.
1934. Micrometeorology. *Curr. Sci.*, 2, 445.
- (With KATTI, N. S.) The variation of moisture in the surface. Layer of the soil in relation to the diurnal variation of meteorological factors. *Curr. Sci.*, 2(1), 24.
 - (With DRAVID, R. K.) Soil temperatures. *Curr. Sci.*, 3(6), 226.
 - (With KATTI, M. S.) Agricultural meteorology, preliminary studies on soil moisture in relation to moisture in the surface layers of the atmosphere during the clear season at Poona. *Indian J. agric. Sci.*, 4(6).
 - (With KALAMKAR, R. J., and GADRE, K. M.) Agricultural Meteorology. Studies in microclimatology. *Indian J. agric. Sci.*, 4(3).
1935. (With KALAMKAR, R. J., and GADRE, K. M.) Agricultural meteorology. Studies in microclimatology. *Indian agric. Sci.*, 5(1).
- Correlation of general crop observations with meteorological data. *Rep. Conf. Emp. Met. London*, 173.
 - Frost hazard in India. *Curr. Sci.*, 3(2).
 - (With RAMANATHAN, K. R.) Derivation of angstrom's formula for atmospheric radiation and some general considerations regarding nocturnal cooling of the air layers near the ground. *Proc. Indian Acad. Sci.*, 1, 822.
 - (With RAMANATHAN, K. R.) The transparency of the atmosphere in the ultraviolet and possible means of extending spectrum in the regions 2200–2000 Å. *Proc. Indian Acad. Sci.*, 1(308).
 - (With KATTI, M. S.) The diurnal variation of moisture in the soil during the clear seasons. *Curr. Sci.*, 3(12).
 - Report on the progress of agricultural meteorology in India 1932–34. *Kommission fur Landwirtschaftliche Met. Protokolle der Tagung, Danzig*.
 - Measurement of evaporation with special reference to (a) water supply and (b) agriculture. *Rep. Conf. Emp. Met. London*.
 - Note on soil temperature. *Rep. Conf. Emp. Met. London*.
1936. (With KATTI, M. S.) Studies on soil moisture in relation to moisture in the surface layers of the atmosphere during the clear season at Poona. *Indian J. agric. Sci.*, 6(6).
- (With DRAVID, R. K.) Soil temperature in relation to other factors controlling the disposal of solar radiation at the earth's surface. *Proc. natn. Inst. Sci. India*, 3(3), 131.
 - (With PARANJAPE, M. K.) An interferometric method of measuring temperature and temperature gradients very close to a hot surface. *Curr. Sci.*, 4, 9.
1937. (With SREENIVASIAH, B. N., and RAMAN, P. K.) Variation in the nocturnal radiation from the sky with zenith distance and with time during the night. *Proc. Indian Acad. Sci.*, 4(45).
- The dust-free or dark layer surrounding a hot body in relation to the convective movements in its neighbourhood. *J. Univ. Bombay* 6, 2, 18.
 - Crop protection from the effects of weather. *Proc. Crop. Soil. Wing Bd. agric. anim. husb.* December.
 - *Report on Simple Methods of Measurement in Agricultural Meteorology.* International Commission on Agricultural Meteorology, September.
 - *Report on Invisible Condensation.* International Commission on Agricultural Meteorology.
 - *Report on Possibility on Influencing Climatic Environment for given Practical Purposes.* International Commission on Agricultural Meteorology.
 - *Report on Hailstorms in India.* International Commission on Agricultural Meteorology.
 - (With NARASIMHAN, N.) The prediction of the minimum temperature on clear days in selected stations in India. *Indian J. agric. Sci.*, 7, 745.



1938. The sun as a source of power. *Symp. Power. prod. India. Indian Acad. Sci.*, **12**.
 — (With SATAKOPAN, V., and GOPAL RAO, S.) Frequency of days with hailstorms in India. *Indian J. agric. Sci.*, **8**, 787.
 — The variation with height of the water vapour content of the air layers near the ground at Poona. *Bioklimatische beiblatter, Heft*, **1**, 30.
 — (With MALLIK, A. K.) The exchange of moisture between air layers near the ground and substances like soils, plant leaves seeds, etc. exposed to the atmosphere. *Curr. Sci.*, **6(9)**, 452.
 — (With VAIDYANATHAN, P. S.) Studies on the spreading of certain substances on clean surface of water. *Proc. Indian Acad. Sci.*, **7**, 186.
 — (With KALAMKAR, R. J.) Statistical investigations on crop weather relationships in India. *Sankhya*, May.
1939. (With MALLIK, A. K.) The thickness of the surface layer of the soil exchanging moisture with the adjacent air layers during the clear season at Poona. *Curr. Sci.*, **8(4)**, 164.
 — (With MALLIK, A. K.) The loss of water by evaporation from the surface of soil columns resting on a water table. *Curr. Sci.*, **8(6)**, 264.
 — (With SREENIVASIAH, B. N., and RAMAN, P. K.) Variation in the nocturnal radiation from the sky with zenith distance and with time during the night. *Proc. Indian Acad. Sci.*, **8**, 386.
1940. (With JOGLEKAR, S. Y.) Further experiments on the repulsion experienced by objects when placed in a thermal gradient. *Sci. Congr.*
 — Cold waves and frosts. *Indian Fmg.*, **1(11)**, 531.
1941. (With PIMPAWADKAR, P. V.) The frequency of high temperatures in India. *Proc. Indian Sci. Congr.*, **41**, 245.
 — (With JOGLEKAR, S. Y.) Studies in thermal repulsion. *Proc. Indian Acad. Sci.*, **13**, 374.
1942. The effect of climatic factors on plant growth crop yield and the incidence of pests and diseases. *Proc. 4th meet. Crop. Soil. agric. anim. Husb.*
 — (With MALLIK, A. K., and PANDIT, U. P.) The effect of concentration on the capillary movement of water and some salt solutions through the black cotton soil. *Curr. Sci.*, **11(7)**, 288.
 — (With MALLIK, A. K.) Studies on soils Part I, the upward movement of water and salt solutions on black cotton soil. *Proc. Indian Acad. Sci.*, **16(1)**,
 — (With MALLIK, A. K.) Studies on soils, Part II. A microscopic study of the behaviour of the black cotton soil and salt solutions. *Proc. Indian Acad. Sci.*, **16(1)**, 16.
 — Climatic factors in agriculture. *Indian Fmg.*, **3(5)**.
1943. (With GOPAL RAO, S.) Frequency of floods and droughts in India. *Proc. Indian Sci. Congr.*
1944. (With MALLIK, A. K.) On the effect of concentration of sodium carbonate in aqueous solution on (a) the formation of cracks, (b) swelling and dispersion and (c) capillary ascent in the black cotton soil. *Curr. Sci.*, **13(2)**, 42.
 — Meteorology of the air layers near the ground. *Tech. Note. India met. Dept I* (3).
 — Meteorology of the air layers near the ground. *Tech. Note India met. Dept.*, **2(9)**.
1945. Meteorology of the air layers near the ground. *Tech. Note. India met. Dept.*, **21(3)**.
1946. (With RAMAN, P. K.) A method of estimation of the thickness of the laminar layer above an evaporation water surface. *Proc. Indian Acad. Sci.*, **23**, 127.
 — Rainfall of India—A brief review. *Emp. J. experimental Agric.*, **24(54)**.
 — The microclimates of plant communities. *Indian Econ.*, **1**, 1.
 — Investigation on microclimatology. Symposium on atmospheric processes. *Proc. natn. Inst. Sci. India*.
1947. Microclimate in relation to topography. *Proc. Indian Sci. Congr.*,
 — On the meteorological conditions favourable for the use of insecticides or fungicidal sprays and fumes inside plant communities. *Proc. Indian Sci. Congr.*
 — (With MALLIK, A. K.) Studies on soils, Part III : on the effect of some salts in aqueous solution on capillary ascent, dispersion and associated phenomena in the black cotton soil. *Proc. Indian Acad. Sci.*, **26(1)**.



1948. The physics of the bottom layers of the atmosphere *Pres. Addr., Phys. Sec. Indian Sci. Congr., Patna.*
- Soil moisture and evaporation investigations. *Cent. Bd. Irrig. J.*, 5(3).
 - *Report on Evaporation from Bare Soil in Relation to the Depth of the Water Table or the Zone of Saturation.* Int. Uni. Geodesy & Geophys., Oslo. August.
 - Some new instruments and experimental techniques developed in agricultural meteorology section at Poona. *J. scient. ind. Res.*, 7, 16.
1949. Effect of salts on soil permeability and rectification of alkali ridden soils. *J. scient. ind. Res.*, 3(3).
1951. Microclimatological investigations in India. *Arch. Met. Geophys. Bioclim.*, III(13).
1952. Desert hydrology condensation and evaporation phenomena in the Rajasthan desert. *Bull. natn. Inst. Sci. India*, 1, 198.
1953. *Hydrology of the Semi-Arid Tracts of Peninsular India.* *Bull. Symp. natn. Inst. Sci. India*, No. 5.
- Convective phenomena near a heated surface. *Proc. Indian Acad. Sci.*, 37(2).
1954. The movement of moisture through the soil. *Proc. Symp. Ground Water, Publ. No. 4, Cent. Bd. Geophys.*
- (With GOPAL RAO, S., and JAGANNATHAN, P.) Prediction of the date of establishment of the southwest monsoon along west coast of India. *Indian J. Met. Geophys.*, 5(4).
1956. (With YEGNANARAYANAN, S.) Solar Energy in India. *Proc. Symp. Wind. Sol. Ener.*, UNESCO, 188.
- (With RAMAKRISHNAN, K. P.) Wind energy in India. *Proc. Symp. Wind. Sol. Ener.*, UNESCO, 42.
 - Phenomena controlling the thermal balance at the ground surface. *Proc. UNESCO Symp. Climat. Microclim.*, Canberra.
 - Microclimatic aspects of housing. *Proc. Res. Symp. natn. Buil. Org.*, New Delhi.
1957. Agricultural meteorology. *Proc. Pan. Paci. Sci. Congr. Meteor.*, Bangkok.
- Natural and artificial modification of microclimate. *Weather*, 12(8).
 - Evaporation and potential evaporation over the Indian sub-continent. *Indian J. agric. Sci.*, 27(2), 137.
 - Evaporation control. *Indian J. Met. Geophys.*, 8.
1958. The establishment, fluctuation and retreat of the southwest Monsoon of India. Special monsoon number of the *Indian J. Met. Geophys.*
- Agricultural meteorology. *W. M. O. Bull.*, October
 - Evaporation control : Precautions to be observed in evaporation control experiments. *Leaflet, CSIR, New Delhi*, No. 1.
1960. *Crops and Weather in India.* Special monograph. Indian Coun. Agric. Res. (Covering 127 pages with 56 illustrations).
1961. Solar radiation and its measurement at a network of stations, with particular reference to India. *U.N. Conf. new Sour. Ener. Rome*, 8.
- Weather and crops. *Hand bk. ICAR.*
1963. Article on control of water evaporation, Poona. *Symp. J. scient. Ind. Res.*, 22(4).
1964. Sensitivity and quickness of response of an enclosed thermopile in relation to the pressure of the gas in the enclosure. *Int. Radi. Conf. Leningrad.*
1966. On the spreading of surface active organic compounds as monomolecular films on a clean water surface and the use of some of them for evaporation control. *Proc. int. Symp. Water Evapor. Control*, Poona, India.
1968. Monsoon and rainfall pattern in the Indian sub-continent. Special Chapter contributed to the Book on *Rivers of India.* Int. geogr. Congr.
- The cold layer above dry ground during clear nights. *Proc. WMO/IUGC Symp. on Radiation including Satellite Techniques. Bergen, Tech. Note No. 104 of WMO*, 399.
 - The phenomena at the earth-atmosphere boundary. *Proc. Symp. Inst. Soil Phys. ICAR* 179.



- Thermal balance at the earth's surface. *Proc. Symp. Inst. Soil Phys. ICAR*, 187.
- Climate as a major factor in shaping the cropping pattern in India. *Proc. Symp. Cropping Pattern, ICAR*
- 1969. Fundamental facts of crop-growth in relation to environment. Precautions to be kept in mind in attempts to establish crop-weather relationships by statistical treatment of data. *Symp. on Crop, Weather and Water Relationship in Agric. Proc. of 23rd Conf. Soc. Agric. Statist., Bombay*, 106.
- 1970. Some recent studies on the restoration of permeability to water of soils rendered impermeable earlier by the swelling action of soil colloids by sodium carbonate. *Curr. Sci.*, **39**(20), 454.
 - The scientific basis of evaporation control by mono-molecular films. *Int. Hydro. Decade. Newslet.* **10**, 17.
- 1971. Weather on the sub-continent of India. *Sou. Int. Symp. Soil. Fert. Evalu.*, 32.
 - Professor Raman, C. V. and the colour of the sea. Sir C. V. Raman Memorial Number *Curr. Sci.*, **XL** (9), 224.
 - Spreading of surface active organic compounds as monomolecular films on a clean water surface. *Indian J. pure appl. phys.*, **9**(11), 1004.
- 1971. Dr Raman, C. V.—Part I. *Indian J. Phys. Teach.*, **1**(1). Contributed as opening article of this new journal.
- 1972. Improvement of structure and reclamation of alkali lands in India. *Bull. Indian natn. Sci Acad.*, **44**, 175.
 - Studies of evaporation, potential evaporation from wet land surfaces, evapotranspiration and allied problems. *Proc. Intr. geogr. Congr.*, University of Toronto, Ontario, 34.
- 1973. Dr Raman, C. V.—Part II. *Indian J. Phys. Tech.*, **1**(3).
 - Droughts and floods in India and some other countries near and far from India. *Proc. INSA Symp. Drought in Asiatic Monsoon Area.*
- 1976. The environment in relation to agriculture. *Proc. Symp. INSA*, 97-115.
 - Basic facts of cloud physics and techniques for the assessment of cloud seeding trials. Presented at the *Symp. Weath. Modifi.* held in February by the Indian met. Soc.

