

Yelavarthy Nayudamma

Scientist, Leader, and Mentor Extraordinary

J Raghava Rao and T Ramasami

This is not the profile or an account of the scientific contributions of an individual but a sharing of personal experience with a visionary, missionary and grass-root researcher – Yelavarthy Nayudamma – who made the Central Leather Research Institute (CLRI) rise to glory. His is a life that raises the hopes and aspirations of youth from small towns. His contributions are part of a living legacy. His research on the shrinkage¹ phenomena of leather and the theory of tanning has stood the test of time. His leadership qualities carry many lessons for leaders of scientific establishments for generations to come. The League of Nations heeded as Nayudamma spoke for the cause of developing nations and for connecting science to development. Theory and practice for him were like two eyes essential for depth vision. For many who knew him he is a living inspirational spirit – his legacy lives long after his passing away in a tragic air crash in 1985.

Introduction

The indomitable spirit of Yelavarthy Nayudamma is interwoven closely with the history and legacy of the Central Leather Research Institute. Nayudamma was born in a family of farmers from a small village in Andhra Pradesh. He chose to undertake doctoral research in leather science under the guidance of E R Theis in Lehigh University, USA. He returned to India to join the newly established Central Leather Research Institute as a scientific officer. He was hand-picked by the first Prime Minister of India, Pandit Jawaharlal Nehru, to the office of the Director, Central Leather Research Institute, after a personal interview at midnight. Nayudamma was then just 36 years of age. He led the Institute from the front for more than 13 long years. The leather world came to associate the Institute with his name during the



(left) J Raghava Rao is a Senior Scientist in Central Leather Research Institute. He carried out his doctoral thesis under the supervision of T Ramasami.

(right) T Ramasami is a Former Secretary to the Government of India in the Ministry of Science and Technology (during May 2006 to April 2014) and Former Director, Central Leather Research Institute (1996–2006). He was a student of Nayudamma at the undergraduate level.

¹ Area loss on heating beyond critical temperature.

Keywords

Nayudamma, CLRI, leather, shrinkage, grafting, collagen, futurology, technology.



Figure 1.

(a) Yelavarthy Nayudamma
(b) Nayudamma's ancestral house at Yelavarru, AP in 2014.

(c) Y Nayudamma, DGSIR visiting CLRI stall at TGT, 1975.

(d) Nayudamma giving roses 'made of leather' to Pandit Jawaharlal Nehru.



² A major fibrous protein present in animal kingdom.

second half of twentieth century. He was an institution builder par excellence and strived to connect laboratory to the land. He was equally adept in discussing the structure of collagen² with Professor G N Ramachandran as he was in deliberating trade related subjects with Sri Nagappan, a game changer in the Indian leather sector.

Nayudamma laid the foundation for collaboration among the trinity of academy–research–industry in the Indian leather sector. The social outcome of the foundation for collaboration among the trinity is significant for India. By the time he was called upon to lead the Council of Scientific and Industrial Research (CSIR) at the age of 49, he had already scaled new heights as an inspiring leader. He was able to make ordinary people deliver extraordinary values. His art of persuasion was matchless. He was able to attract great scientists for addressing the call of the nation. He contributed strongly in shaping the future of Indian research. He carried his



conviction for connecting scientific discoveries with their logical applications in real field conditions. Under his leadership, CSIR could boast of several technologies with national outcomes. He was also the architect of what has come to be called Graduate Aptitude for Technical Education (GATE).

Nayudamma set the stage for socially inclusive and affordable innovation ahead of his time. He spoke clearly about the grammar of science and technology for developing countries. He was the founder president of the Committee for Science and Technology for Developing Countries (COSTED) and a member on the Board of Governors of the International Development and Research Council (IDRC). While returning home, after the meeting of the Board of Governors of IDRC in Canada, he became a victim of the Kanishka air crash off the coast of Ireland on 23rd June 1985 at the age of 62. One of the authors (TR) was an undergraduate student, mentored with care by Nayudamma. His writings and speeches reproduced in a publication brought out by Nayudamma Memorial Science Foundation [1] capture the profile of a man with a never-dying spirit and a strong purpose in life.

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Family Life

Nayudamma was the eldest son of Anjaiah and Raghavamma. He was born on 10th September 1922 in Yelavarru, a small village un-connected by proper roads, with limited infrastructure and very few amenities. He may have moved out of a village, but none could remove the village from him. His father remained a hero to him all his life. Nayudamma was married to Sita Devi and the couple had three children Rathiesh, Shanti and Ramesh. Tragedy struck Nayudamma early in his married life as Sita Devi succumbed to brain tumour. Later in his early forties, Nayudamma married Pavana Bai, a distinguished medical doctor. They were soul mates. Nayudamma was more than a father. He was a mentor, friend, and philosopher and guide all rolled into one for all those who came into contact with him. His personal life has been chronicled and books have been published [2, 3].



A Turning Point

Nayudamma went to a primary school in Yelavarru, high school in Thurumella, intermediate in A. C. College, Guntur, and undergraduate degree course in industrial chemistry at Banaras Hindu University in Varanasi. After graduation from BHU in 1942, he joined the Law College in Chennai, then Madras. An accidental meeting with Seshachalam Choudhary changed the course of his life. Choudhary was then head of the Leather Technology Institute in Washermanpet, Madras. Nayudamma joined the Institute of Leather Technology on 17th June 1943 at a salary of Rs 17 per month. This was a turning point in his life. He was sent to UK by the Government of India for advanced training in leather science at the University of Leeds. After a brief period in UK, he chose to move to Lehigh University in the United States to work with Edwin R Theis for doctoral research. He sought to understand the practical implications of various steps associated with tanning³ using chromium salts as a part of his doctoral training. Focus of his doctoral research was essentially on solving industrially relevant problems. His research papers in early life generally focused on results of practical value to tanners. After his doctoral degree, he chose to work in the shop floor of a tannery in the United States. Throughout his active professional life, he remained convinced of the value of hands-on experience to industrial research.

³ Permanent preservation of a putrescible skin/hide.

Some Important Scientific and Technological Contributions

Mechanisms of Tanning

Understanding the mechanisms of tanning, i.e., permanent preservation of raw hide, was a priority among leather chemists of the world at his time. Nayudamma and his co-workers at the Central Leather Research Institute actively pursued research in this area. In those days, recognizing the sites of collagen, the skin protein, and the mode of binding of tanning species was the main focus of research. Nayudamma and his co-workers were able to get new insights into the binding of various tanning materials to skin proteins. It was then generally believed that each tanning system



adopted different pathways and mechanisms for preservation against bacterial degradation and for according dimensional stability to leather against heat. He emphasised the need to understand all features of the tanning phenomena in a comprehensive manner. One of us (TR), an undergraduate student then, was challenged about the need for finding a unified theory for tanning by Nayudamma. Many years later such a unified theory was proposed by CLRI. Experimental demonstrations of thermal stability being related to long-range ordering induced by tanning species and resistance to bacterial degradation being controlled by the ability of tanning molecules to deactivate collagenase were made. The roles of de-solvation and hydration phenomena were better defined. The work of Nayudamma on the mechanism of tanning and shrinkage phenomena provided the lead for such fundamental investigations.

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Unravelling the Mysteries of Shrinkage Phenomena in Leather

As a scientist, Nayudamma was different. While many of his contemporaries focused on discoveries of new phenomena, he sought solutions to real life problems through research. Shrinkage phenomena of skins and leather mattered to him significantly. Dimensional stability of skin and leather bears large economic value to the traders and users of leather products. He wrote a chapter in *Treatise in Leather Sciences and Technology* edited by O'Flaherty on shrinkage phenomena. It is a masterly article and is still used as a textbook material world over. Considerable research in the area that followed his original masterpiece has added more details, but the substance has remained mostly unchanged. It was an article of insight into a complex phenomenon gained through a synthesis of knowledge available then. Now, factors controlling matrix stability and shrinkage phenomena of collagen and leather are better understood.

Defining the Benefits of Combination Tanning

Nayudamma and his co-workers were generally concerned about the use of combination tanning to impart desirable properties to



⁴ Using multiple types of materials for tanning.

leather. He and his co-workers demonstrated the benefit of combination tanning with vegetable and aluminium for manufacturing water-proofed sole leather, which was a classic observation. Inspired by Nayudamma, some pioneering work on benefits of ‘combination tanning’⁴ was carried out in CLRI. Many of the combination tanning techniques developed by Nayudamma and his co-workers were adopted by the tanning industry in India, and based on his combination tanning work, several commercially useful products were developed for tanning in later years.

Nourishing the Root of Science in Collagen Research

⁵ Structure involving three helices wound around each other.

For the elucidation of the ‘triple helical structure’⁵ of collagen by G N Ramachandran and his group, Nayudamma carried a specimen of kangaroo tail tendon from Australia and provided a purified sample of collagen fibre. What was later called the ‘Madras Triple Helical Structure of Collagen’, and considered as one of India’s foremost discoveries was made on the sample provided Nayudamma by G N Ramachandran and co-workers in 1954. Whether it was biophysics, structural biology or nutrition-related disorders in collagen synthesis, Nayudamma strived to foster good basic research. Ramanathan and Nayudamma addressed the effect of radiation on the structure stability of collagen fibres and made some fundamental contributions. He believed that unless one nourished the root, one cannot get good fruit. Generosity in supporting basic research was not just a virtue, but a call of duty for him. In later years, CLRI emerged as one of the major centres in the world in the development of smart collagen-based biomaterials. The seed for relevant research on collagen-based biomaterials was sown in CLRI by Nayudamma.

“At this time, an integrated study of the chemical, mechanical and hydrothermal study of collagen and leather is very desirable”.

– *Nayudamma*

Source: O’Flaherty,
Vol.2, Ch. 16, pp.28–60,
1958.

Grafting Synthetic Polymers to Skin and Leather

Nayudamma was a champion of collaboration in scientific research. At the neighbouring campus of the University of Madras, Santappa, was actively pursuing techniques of grafting acrylic monomers on to various biopolymers. Nayudamma foresaw grafting acrylic monomers on to collagen and skin as a means of



upgrading lower quality raw hides⁶ and skins⁷ and as a technology of value addition. An active collaboration was set in motion between two equally renowned scientists. The Madras group did pioneering work in this area and several original scientific publications and patents emerged from this collaborative work. Today, the grafting technique has found a range of applications from tanning to dentistry.

⁶ Covering of a bigger animal.

⁷ Covering of a small animal.

Nation Building through People and Institutions

Nayudamma called himself a farmer by birth and cobbler by profession. He saw in leather science and technology an opportunity to transform a hereditary avocation into an organized industry participating in a global trade. He believed that technology could overcome societal barriers plaguing the leather sector and promote social equities among people. For him the development of India through a vibrant leather export trade through value addition to raw hides and skins from India by application of technology was a cause. He saw in CLRI, an institutional mechanism to achieve what Mahatma Gandhi wanted.

Nayudamma became an agent of Gandhian thought and practised in spirit what Gandhi preached. He believed that the role of CSIR institutions is to design, develop, deliver and disseminate technologies which matched the need of a developing country. He believed in extension as a mechanism of technology transfer. He developed several original models for technology dissemination and transfer from CLRI to industry. He launched “Tanners’ get-together” (a research-industry meet) as an annual event in the last week of January. He introduced ‘International Leather Fair’, industrial exhibition every year. The venue was CLRI. Under his extraordinary leadership, CLRI became a Centre of Excellence in leather research globally and an institute of relevance nationally.

Pre-eminence of CLRI was on account of the uniqueness of CLRI in relating to technology to leather industry in the country. Because of his leadership, there was a defining connection among technology-led changes in leather industry, vibrant global trade of

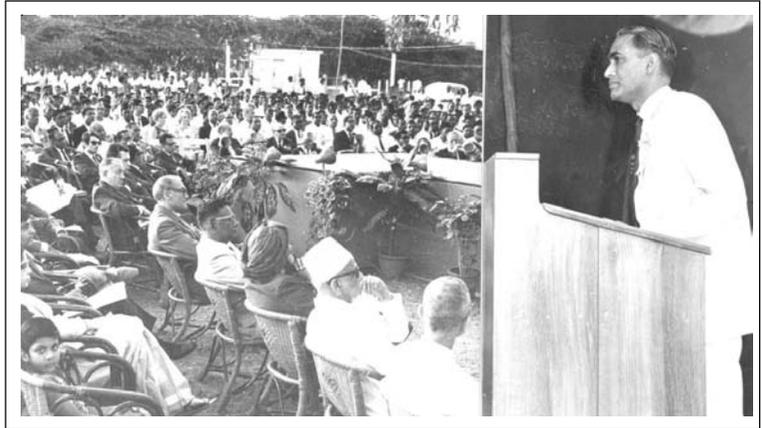
“It is estimated that rupees nine crores worth of raw hide is annually exported from India and that much of it is returned to her in the shape of manufactured articles. This means not only a material, but also an intellectual, drain. We miss the training we should receive in tanning and preparing the innumerable articles of leather we need for daily use.”

– *MK Gandhi*

Source: On Tanning, *Harijan*, Vol.7, No.9, 1934.



Figure 2. Nayudamma welcoming the invitees during the inauguration of TGT, 1965.



“The best way for an institute to sell its research is for it to go to the industry and say, “You take the profits, we will take the losses.” This approach will help with the industry’s confidence in the institute and thus make the industry more receptive to future possibilities of benefit from research.”

– *Nayudamma*

Source: *Minerva*, Spring, Vol.V, pp.323–39, 1967.

India in leather-related products and empowerment of women and weaker segments of the society. On the whole he believed in social causes and in the use of technology in addressing them. To him CLRI was an inspiration for his entire life to accomplish what he stood for. Nayudamma and CLRI are inseparable..

Nayudamma was a shrewd investor in youth. He believed that the future of a nation was in its value systems and the effort of its youth. He was a teacher who made the learning happen in the minds of the learners rather than trying to impart learning from outside. Enquiring minds were his targets. He permitted academic irreverence among his students as a Nayudamma trade mark. His questions were provocative and answers thought provoking. He was a man who knew the importance of youth and the

Figure 3. International leather fair, ILF 1964 at CLRI.



wisdom of investing in it. He believed in Science and Technology Entrepreneurship. He challenged several of his students to become employers rather than seeking employment. Science and Technology and Entrepreneurship Programme (STEP) being implemented by Department of Science and Technology was his brain child. He seeded the early thoughts on entrepreneurship in 1969. He was a true mentor to his students.

Driving Technology through Policy and Foresight

India during the nineteen sixties was primarily a source of raw hides and skins and processed intermediates in the global trade. Policy driven changes for shifting the export basket from raw hides and skins and semi processed leathers were conceived and promoted. Ban on the export of raw hides and skins and semi processed leathers on the one hand and incentives for export of finished leather were the policy instruments developed by him. Nayudamma was concerned about the environmental issues concerning leather processing as early as 1960s. He developed a separate division in CLRI for developing technologies for waste water treatment in tanneries. He persuaded tanners to establish a waste water treatment plant based on CSIR technologies in the 1960s. He adopted a Public Private Partnership model for investments for establishing the effluent treatment plant in a tannery in

“Another way in which the CLRI helps to create the outlook that is necessary for the growth of a science-based industry is to attract new students to the leather industry by trying to arouse interest among the young.”

– *Nayudamma*



Figure 4. Nayudamma welcomes the delegates at ESCAP seminar on Futurology for leather

“It is generally agreed that science and technology are the propellents to growth and modernization; progress and prosperity; and power and prestige. Even the old time economists acknowledge that the static elements of land, capital and even raw materials are now replaced by the dynamic elements of technology.”

– *Nayudamma*

Source: IAEC Endowment lecture delivered at Bangalore University, November 1972

the 1960s. CLRI under his leadership vigorously raised the environmental concerns relating to leather processing. The concept of common effluent treatment plants for treating waste waters from a group of tanneries was a thought seeded well ahead in the industry due to the leadership of Nayudamma. He held a unique ability to foresee the value of emerging technologies for promoting the growth of Indian leather sector. As early as 1965, he established a National Centre for Leather and Allied Information in CLRI and invested in ‘Futurology’ exercises for predicting the directions that global leather technology might follow. He built a social contract for science and technology and related research and development to benefit the nation.

At the Helm

Nayudamma was appointed as the Director General of CSIR on 27th August 1971. It was a period of transition. The challenges faced by the CSIR were on many fronts. He provided charismatic leadership. He attracted several Indian researchers abroad to return and work in India. R A Mashelkar, who later became the Director General CSIR, was his appointee as a senior scientist in the National Chemical Laboratory during one of his visits abroad. Nayudamma appointed one of us (TR) as a Scientist on Ad-hoc basis within hours after returning to India with a PhD from Leeds. Nayudamma scouted and spotted talent for CSIR. He emphasized the importance of connecting research and development outputs of CSIR to society. He was the main player in designing national policies for research and development. He undertook a bold experiment for providing technology-led changes in rural India with Karimnagar in Andhra Pradesh as the model centre. The experiment may not have succeeded then, but it was an innovation well ahead of its time. Nayudamma was able to gain the support of the political will and provided a rare level of leadership in the science sector.

Sweeping changes were taking place in the external environment during the emergency period. The science and technology system had to readjust to the realities of the environment. Being a



practical person, he felt that he should return to research-related activities and moved back to CLRI in 1977. He started to focus on science-led technologies for rural development. Many techno-social experimental and pilot projects were mounted. He was called upon by the Government to provide leadership to the Jawaharlal Nehru University. On 12th June 1981, he arrived at the university and assumed charge as Vice-chancellor. He served JNU for a period of sixteen months and decided to leave prematurely. He did not consider his stint in JNU an adequate success. "He did not enforce his authority enough," is the view of one of the detractors of his leadership model. Finally, he arrived at his favourite institution, CLRI for spending the rest of his professional life. He became an advisor to several state Governments on matters relating to science, education and industrial development.

Recognitions

Nayudamma received several awards and recognitions in his life for his professional leadership; K G Naik Gold Medal, Padma Shri of the Government of India, fellowships of the Indian Academy of Science and the National Academy of Science to name a few.

Nayudamma was an advisor to Food and Agriculture Organization (FAO), United Nations Industrial Development Organization (UNIDO) and in later life International Council of Scientific Union and International Development Research Centre and many



Figure 5. Nayudamma with delegates of Food & Agriculture Organization (FAO) at CLRI.



Nayudamma was a member of several international bodies. UN organizations relied on his wise counsel.

other developmental bodies engaged in science- and technology-based activities. He worked out developmental plans for the promotion of leather and allied sector in developing countries for implementation by organizations like FAO and UNIDO. His visionary attributes combined with missionary zeal made him a unique global leader in technology related areas in his time. In later part of his life, he focused on education, appropriate technology for rural development, and technologies for developing countries for meeting their agricultural and energy needs. His vision was global and actions were down to earth and local. He was a strong and vocal advocate of people-centric science. He grew into a voice for “science for society” among the League of Nations. His international stature was tall and glowing. He was a member of several international bodies. UN organizations relied on his wise counsel. As the President of the Committee on Science and Technology for Developing Countries (COSTED), he spearheaded a movement for the integration of traditional and emerging technologies. Several international assignments and positions were offered to him when he was the Director General of CSIR. He turned them down in the larger interests of his home country.

Concluding Remarks

Pascal wrote, “The strength of man’s virtue should not be measured by his special exertions, but by his habitual acts”. Nayudamma’s habitual acts were caring for others and relating science and technology for meeting the needs of the common man. He was a leader of a very special type. His natural warmth captivated most of his surrounding and his pleasantness in personality arresting and compelling. Finding solutions through science was his natural choice. Ease of practice and ability to reach the un-reached were his criteria for selection of technologies. Innovation for inclusive development was his mantra long before such terms were coined by the world. Generosity and gentleness were part of his personality. His virtues were many and limitations few.

Our former President R Venkataraman had the following to say



about Nayudamma; “It is for the grammar of tense, he needs to be spoken in past tense. In the grammar of life, he is a continuum.” Many of his students and their students remain inspired for life. Both the authors TR and JRR represent his legacy. They carry out his missions forward and spread his message of ‘science for people’. His greatness was not only from the speciality of his discoveries but also from their ability to solve problems that people wanted solutions for. His goodness is not just from what he preached but what he practised every day. He was too remarkable to be captured in words. He had to be experienced as a man. Those who knew him will continue to feel him as a living spirit that will never perish.

Acknowledgements

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Suggested Reading

- [1] K A Ramasamy and K Seshagiri Rao (Eds), *Science, Technology and Education for Development*, Nayudamma Memorial Science Foundation, Chennai, 1999.
- [2] N R Rajagopal and G Thyagarajan (Eds), *Reminiscences*, Central Leather Research Institute and Insdoc, New Delhi, 1986.
- [3] K Chandrahas, *The People’s Scientist Dr Y Nayudamma: A Biography*, First Edition, Pegasus India Publishers, 2013.

“The policy must be in favour of rural people and strategy should be to use science and technology as a deliberate tool to achieve this goal. Research should be relevant and education interlinked to the process of development.”

– *Nayudamma*

Source: Keynote address to the Tamilnadu Academy of Sciences, Madras, 22 December 1977.

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