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Combating Desertification In Arid Zone Of Rajasthan

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THE Great Indian desert forms a part of Thar desert which extends over Pakistan in the west. The arid zone in India covers about 12 percent of the country's geographical area and occupies over 3.2 lakh sq km of hot desert located in parts of Rajasthan, Haryana and Gujarat besides small pockets in peninsular India. In addition to this, an area of about 70 000 sq km of cold desert in Ladakh in Jammu and Kashmir presents entirely different set of agroclimatic conditions as compared to the hot desert. About 62 percent of the hot arid areas of the country is located in Rajasthan. Roughly three-fifths of Rajasthan lying north-west of Arravallies falls within the limit of arid zone and it comprises the 12 western districts of the State, namely, Barmer, Bikaner, Churu, Ganganagar, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur, Pali, Sikar and Sirohi. The arid areas are characterised by acute ecological imbalances. The problems imposed by a low annual precipitation (366 mm) are accentuated by its frequent erratic distribution from season to season, a high solar radiation of 450–550 calories per sq cm per day, and wind velocity of 10.20 km per hour resulting in a high potential evapotranspiration (6 mm/day) and consequent high mean aridity index ranges from 76–78 percent. As a result the subterranean flow of water becomes erratic, groundwater lies very deep generally brackish and saline and there are no perennial rivers. Apart from the Gang and Bhakra Canals in Sri Ganganagar district, there are very few flow irrigational facilities. Added to these, soil salinity and alkalinity complicates the situation.

Desertification

Desertification has been for a long time a common feature of the Rajasthan arid zone. By arid zone standard the Rajasthan desert is one of the most thickly populated deserts of the world, the density of population per sq km being 48 as against 3 persons per sq km in most other deserts of the world. In arid zone of Rajasthan, starting with a base of roughly 3.567 millions in 1901 the population registered a linear escalation and increased to 10.236 millions, thus registering about three-fold increase over the base year 1901. Most of the labour force (over 80 % of the working population) is tied up to a pre-modern agriculture which suffers from an additional handicap of increasing scarcity of crop land. The negative socio-economic effects of the fast growing population in the arid zone of Rajasthan, added to the harsh agro-climatic conditions, are becoming glaringly visible. The man-land-ratio is fast declining. The improved technology has not been adopted to any significant extent by the farming population. As a consequence more and more marginal lands are being brought under the plough, as is evident from the land use statistics, resulting a substantial increase in sown area at the expense of grazing lands. But at the same time the livestock population increases —leading inevitably to the over exploitation of the ever shrinking grazing lands. Crop production on sand dunes and marginal lands is not only low but is also a soil conservation hazard. This contributes to the accentuation of desertic conditions. The yield per unit of cultivated area is exhibiting a declining trend. The annual linear growth rate (1954–70) of principal crops shows a negative trend for pearl millet -0.66, sorghum –4.88, pulses –2.17, sesamum –6.08, gram –1.20 and barley –0.18. The declining yields may be attributed largely to the use of the marginal and sub-marginal lands for cultivation purposes.

Similarly, due to the increase in population and the number of households, not only more land has been brought under plough reducing the number of trees and shrubs, but also the increased demand of wood for fuel which has led to an over exploitation of vegetation resources.

With the persistance of human demands a process of progressive degradation of resources has set in over grazed lands. Shrinking forests and eroded agricultural fields show the imprints of man's activities on his environment. Surveys on the experience of the farmers have further revealed that the region has been experiencing accentuation in conditions of desertification over the last 25–30 years. The dwellers perceived and attributed this process to the prevalence of 'improper winds', lesser precipitation, greater erraticity and uneven distribution of rainfall, resulting in decreased natural vegetation, the appearance of xeric conditions, impoverishment of soil, increasing salinity, lower crop yields and increasing number of famine periods over the last 25–30 years. A reckless exploitation of land, substantial increases of human and livestock population coupled with the above factors thus suggest a corrosive effect

THE ARID ZONE in India constitutes 3.2 lakh sq km of hot desert, 96 lakh sq km of semi-desert and 0.7 lakh sq km of cold desert of Ladakh with an inhabited population of over 19 million. It is the mostly thickly populated arid land in the world —48 persons per sq km as against 3 in other deserts. Picture shows moving sand dunes near Udairamsar about 15 km from Bikaner.

and continuation of desertification trend in the arid zone of Rajasthan.

Combating Desertification

The Government of India, in recognition of the desert problems arranged a symposium in 1952 under the auspicies of National Institute of Sciences. As a recommendation of this symposium, a Desert Afforestation Research Station was established at Jodhpur in 1952 to carry out afforestation research work and forestry extension including the erreotion of shelter belts and afforestation of sand dunes and waste-lands unfit for cultivation of crops. In 1957, the scope of the station was enlarged by inclusion of soil conservation programmes, and it was named as the Desert Afforestation and Soil Conservation Station for conducting researches for development of crop husbandry and grasslands as well. Subsequently, it was felt necessary to establish a full-fledged research institute at Jodhpur for undertaking basic and applied researches for the development of the arid areas of the country. Highlights of some work done at the Institute are presented below.

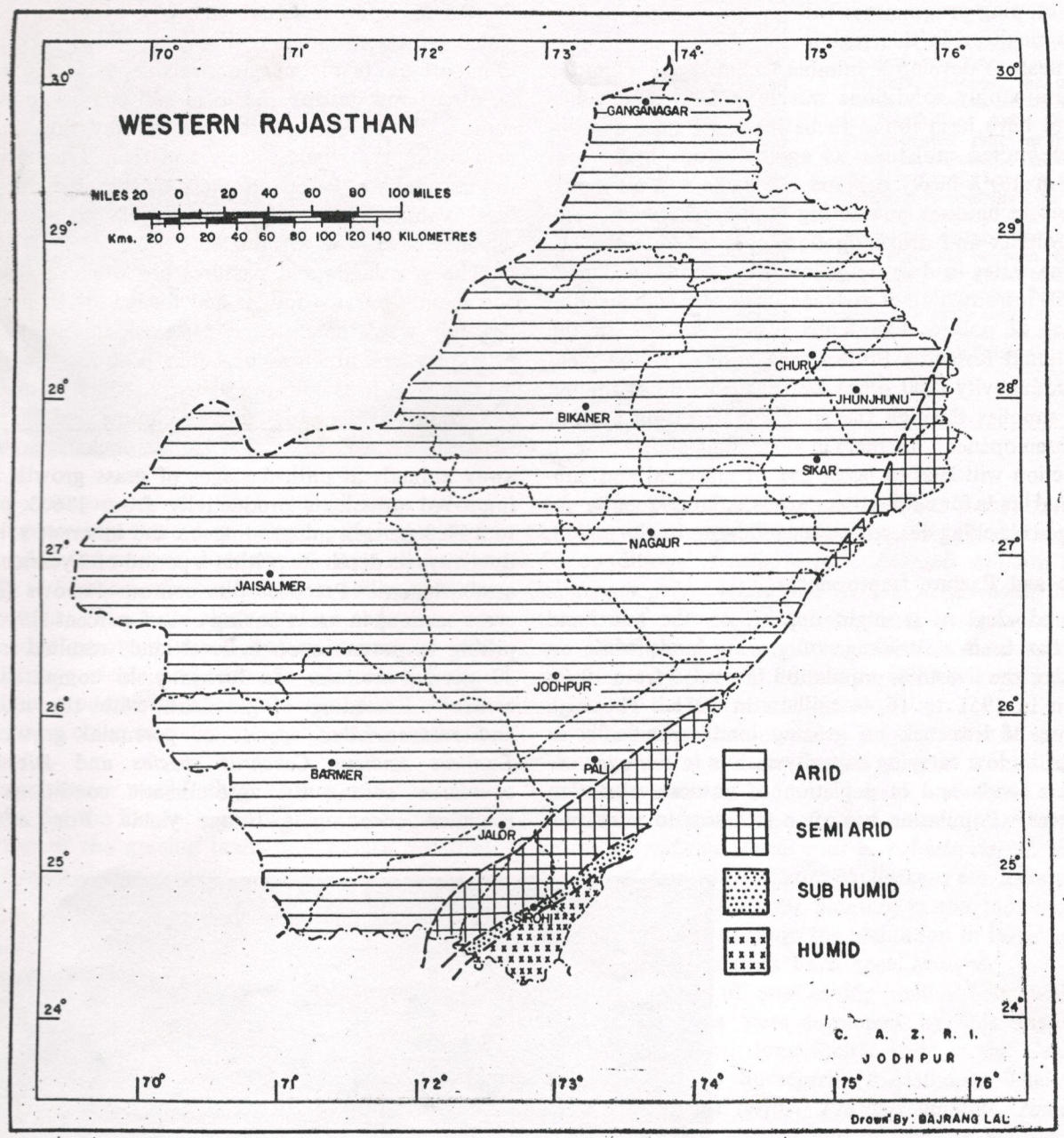
Multi-disciplinary Surveys for Rational Utilisation of Natural Resources

Based on the study of the aridity index, the arid and semi-arid areas in Rajasthan have been delineated. A full knowledge of the available natural resources and their present use in the area is a must before the steps for harnessing the optimum utilisation of these resources could be suggested. For the purpose, multi-disciplinary integrated surveys have been completed in 45 269 sq km area in arid zone of Rajasthan. In addition, semi-detailed surveys have been conducted at the development block level in about 34 000 sq km besides detailed village level surveys in priority areas. These surveys have provided comprehensive information with regard to (a) land use capability classes based on land use data, land forms, erosion hazards (wind and water), soil types and type and intensity of dunes; (b) pasture types; (c) tree communities; (d) water resources (surface and ground water), water quality, water potential zones and their capabilities to supply ground water and village tanks and their water potentials; (e) socio-economic correlations of various caste groups, household structure, rural working force, class of farmers and land holding size, animal-vegetation-human relationships, forms of settlement etc. Integration of these attributes in terms of land resource units provides information on the differential nature of management and conservation needs, resource potential and a scientific basis for developmental planning for major land use policy decision which will go a long way in combating desertification processes.

Crop Production Technology

Arid zone of Rajasthan inherited a poor and undiversified economy crippled through decades of neglect and feudal exploitation. Despite scarcity of water needed for crop production and increasing scarcity of crop lands the majority of workers (over 80 percent) are tied to an outmoded and inefficient agriculture and crops are sown in about 40 percent of the land area annually. Irrigation facilities in the region are limited crop production under rainfed conditions is highly unstable and the crop yields with traditional varieties and package of practices is dismally low. Varieties of the traditional crops like pearl millet and moong beans, possessing high yield potential, synchronous maturity and growth and development rhythms matching the rainfall pattern have been identified and developed.

Improved agronomic practices centering around



efficient fertilizer, herbicide and pesticide use, maintenance of optimum crop stands in relation to moisture availability, tillage, soil and moisture conservation measures bearing a direct relationship with agricultural production in the region have been developed. Crop production strategies befitting varying rainfall patterns and aberrant weather situations have been formulated. Crops like castor and sunflower have been found to perform better than cereals under late sown conditions.

Crop production technology having a direct bearing on desert control has been developed. For instance, it is now possible to adopt a double cropping system on drylands in years of good and extended rainfall. Adoption of remunerative double cropping system like pearl millet—mustard, moong beans—safflower/mustard, early fodder crops-guar beans/castor, will go a long way in giving protective covering to bare soil in the winter season, besides resulting in higher productivity and monetary returns. Simple practices like provision of wind breaks around cropped fields, ploughing across the wind direction, leaving crop stubbles of about 15 cm height or so at harvest, water harvesting procedures, timely cultural operations (particularly weed control) all together, will help ameliorate desertic conditions operating in the arid regions. Inter cropping of annual grain legumes in established pastures of *Cenchrus ciliaris*

etc. and inclusion of crops like cluster beans and castor in the croping programmes will impart stability to dry-land agriculture in this region.

A need to develop a suitable technology for limited moisture supply conditions was long felt. Crops like mustard have been found to be the most efficient utilizers of limited moisture, as against crops like wheat which makes a heavy demand on water and nutrients. Efficient techniques, guaranting optimum water use, like sprinkler and drip irrigation, coupled with the use of saline water in drip irrigation, have been developed. With the introduction of early maturing and high yielding varieties of potato, like Kufri Chandramukhi, in the Operational Research Project, new vistas of high yield and productivity (200 q/ha) and efficient use of limited water supplies through the sprinkler irrigation system, have been opened. Increase in yield and stability in crop production will lead to lesser use of marginal and sub-marginal lands for cultivation purposes, consequently resulting in checking desertification processes in the region.

Range and Pasture Improvement

Paradoxical as it might appear, on the one hand there has been a shrinkage of grazing lands while on the other the livestock population increased from 10.27 million in 1951 to 16.44 million in 1971. The high pressure of livestock on grazing lands specifically in view of its low carrying capacity results in the over use of these lands and in depletion of natural vegetation resources. Population has often to resort to migration and nomadic life for meeting the needs of their livestock. Studies have revealed that each type of nomad is associated with some kind of livestock which make indiscriminate use of the meagre available water and grazing resources and destroy the local soil conservation measures. The nomads in the present day thus prove a menace for the whole society and their sedentarization is inescapable. Based on their kinship structure, cultural values and socio-economic life sedentarization schemes have been formulated.

The grasslands and pastures are valuable resources and mainly provide fodder and forage to the livestock, research was, therefore, undertaken to establish the principles and practices of better pasture management to improve livestock productivity which also would contribute to reclamation and development of the region.

Results have shown that simple enclosures to keep away animals at ctitical stages of grass growth led to improved grassland productivity from 116.3 percent to 148.3 percent depending on the inherent soil productivity, its depth etc., within a period of 2 years of their establishment. Practices like contour furrows (30 cm cross section) in areas having over 5 percent slopes and pitting in pre-monsoon in level lands resulted in over 30 percent increase in forage yield compared with control. Reseeding of grassland with the identified and recommended species of perennial grasses like *Lasiurus sindicus Cenchrus species* and *Dicanthium annulatum* suiting the agro climatic conditions have provided encouraging forage yields. For adequate

MAN'S STRUGGLE against aridity started in antiquity has to continue but with intensive research and extensive application of latest scientific knowledge to suit the local conditions and ecology. The effectiveness of sand dune stabilisation in Shivbari village on Bikaner-Jodhpur Road is seen here. The sand dunes which once threatened to engulf the village are now a vast green patch, full of fodder trees and grasses.

THE SCIENTISTS of the Central Arid Zone Research Institute, Jodhpur, the only research station of its kind in South-East Asia, have demonstrated that far from being an economic liability, the desert areas have a vast potential to contribute to the Nation's economy. Shri S.P. Malhotra, Acting Director of the Institute, is seen here explaining the desert technology for reclaiming barren, salty and sandy soils to the villagers in one of the operational research fields.

livestock management, the feed should nave atleast 7 percent protein in their diet. *Stylosanthes* species is recommended for western districts of Rajasthan and it is likely to be successful because of its ability to withstand drought. The technology evolved together with recommended practices would not only increase and stabilise forage yields and provide additional fodder for livestock productivity but would also give a protective vegetation cover to the existing almost barren lands of the desert.

These measures would, thus, ensure adequate feed and fodder for the livestock and would check excessive exploitation of the grazing lands and reduce desertification hazards in the region.

Sand Dune Stabilization, Afforestation and Shelter Belt Plantation

Dune infested area in Western Rajasthan alone constitutes approximately 58.5 percent of the total area. Of this area 11.5 percent area is very severely (80–100 percent), 4.8 percent severely (60–80 percent), 14.7 percent strongly (40–60 percent) 18.6 percent moderately (20–40 percent). and 8.9 percent slightly (0–20 percent). infested. Techniques of stabilisation of shifting dunes consists of (a) protection of shifting dunes against all biotic interference; (b) effective micro-wind breaks on the windward side of dune either in 5 m parallel strips or 5 m square chess board; (c) sowing of grasses or transplanting of trees and shrub species raised in sun dried earthern bricks on the leeward of micro-wind break. The suitable species for afforestation of the shifting dunes are trees like *Prosopis cineraria, Prosopis juliflora, Acacia tortilis, Acacia senegal, Albizzia labbek;* shrubs *calligonum polygonoides, Lycium barbarum, Acacia jacquemontii: Clerodendrum Phlomoides and Zizyphus nummularia;* and grasses like *Saccharum bengalensis, Lasiurus sindicus, Panicum antidotale, Panicum turgidum, Cenchrus ciliaris and Cenchrus setigerus.* In extremely arid conditions *Acacia tortilis, Prosopis juliflora* and *Calligonum polygonoides* and *Acacia jacquemontii* have been found suitable. The economic analysis of the dune stabilization technology indicated that average annual cost of Rs 760.00 per ha will be repaid after the end of the thirteenth year.

For the afforestation work a large number of species of Eucalyptus, Acacia and other general from similar iso-climatic zones of the world were introduced. Out of different exotic tree species, *Acacia tortilis. A. aneura, A. radiana, Eucalyptus camaldulensis, E. melanopholia, E. terminalis, Cassia phyllodenea* etc. have been found to be promising for planting in the Indian arid zone. For raising saplings for plantation in large numbers, nursery techniques have been evolved.

The technique of establishing shelter belts with a number of species were developed by this Institute after raising 103 km long shelter belts at the Central Mechanised Farm, Suratgarh (Rajasthan). The tree species like *Acacia tortilis, Prosopis juliflora, Tamarix articulata, Acacia nilotica* and *Cassia siomea* recommended for the purpose are fast growing, root firm, form a dense crown cover and litter in abundance in the plantation floor. The species are also drought hardy and frost resistant. This Institute has also evolved technology for raising avenue cum roadside planting along highways (207 km) in arid regions of Rajasthan and also for raising plantations at vulnerable places along the railway track (5 km) to check the movement of sand blowing and covering over the tracks causing hinderance to the rail traffic.

Arid Horticulture

As mentioned earlier there has been over-saturation in cultivation and development of alternate avenues of

livelihood would reduce pressure on lands—a step towards arresting desertification. Research on the development of arid horticulture was, therefore taken up. The arid lands of Rajasthan, except for the irrigated area in Ganganagar district are by and large devoid of fruit trees. The only fruit tree encountered in abundance in the desert tract is *ber* (*Zizyphus nummularia*) which has small size red berries. Looking to its potential for improvement, budding techniques were perfected by which it has been possible to transform these *Zizyphus* bushes into ber varieties such as *gola* and *seb* which are characterised by large size, luscious and tasty fruits with a production range of about 40–60 kg/tree. About 4 000 *ber* seedlings of *gola* and *seb* in the Operational Research Project area have been planted and the programme has been very widely accepted and is achieving a great success. Under dryland conditions, with suitable water harvesting techniques, pomegranate, guava, custard, apple and gonda (Cordia mixa) have been successfully grown. With supplementary irrigations, sour lime and amla may be grown. Under conditions of assured irrigation facility, fruit crops like phalsa, grape, date palm, oranges and papaya can be grown profitably. Preliminary observations have indicated that a seedless variety of pomegranate, the gola and seb varieties of ber, Kagzi lime, Allahabadi safeda, and Lucknow-49 guava, Honey Dew and Washington varieties of papaya and the Beauty variety of seedless grape grow quite well in this region. Detailed varietal evaluation work on these crops is currently under progress. Four date palm varieties, viz. Khadrawi, Medjool, Shamran and Hillawi have flowered four years after planting. In the fifth year, the yield of fruits per palm has been 9.2 kg in Shamran and 5.5 kg in Khadrawi. Sucker production per palm in the fifth year after planting has been 9.8, 9.7, 8.7 and 6 kg in Khadrawi, Medjool, Shamran and Hillawi cultivers respectively.

Rodent Control

Rodent constitute one of the largest mammalian groups in the desert. Their role in intensification of desertic conditions may be comprehended from the total number of species (seventeen) and density, 74 to 523 per ha and biomass 435 to 2 641 gm per ha. Studies have clearly indicated that rodents are potent consumers of the desert biome and are opposed to man in his endeavours for maximising productivity from this inhospitable terrains, and would not permit any grass growth unless their populations are properly managed. The ecology of different species and their bait preferences, shyness, seed consumption, dose response to lethal chemicals, optimum season (May and June) for control etc. have been evaluated. Technology has been established for control of field rodents which cost only 30–45 paisa/ha. No other programme of development would, however, warrant a greater necessity for community action than the rodent control. In the Operational Research area, therefore, emphasis was placed on achieving a consensus which ultimately involved the whole community inhabiting the cluster of five villages, as participants in the programme. This yielded very fruitful results.

Solar Energy Utilisation

The Rajasthan arid zone is blessed with abundant solar energy and researches conducted at the Institute for its utilization have led to successful fabrication of Solar Water Heater, Solar Oven, Solar Cabinet Dryer and Solar Distillation Kits etc. These gadgets are very cheap and cost around Rs 300/- to Rs 350/- only so as to enable the population inhabiting arid zone to make use of this as their own. Efforts are under way for developing a solar pump which would go a long way in combating desertification in arid areas.

NOMADS on the Move in search of water in Rajasthan— A consequence of Desertification.

The use of gobar gas plant has been well demonstrated in the Operational Research Project area adopted by the Institute. There is high demand for installation of the biogas plants as in addition to a saving of about 3 quintals of fuel wood and 1.75 litres of kerosine oil per month, the farmer gets a good farm yard manure and does not have to burn dung cakes.

Operational Research Project

It is thus evident that sufficient technological knowledge has been developed for increasing production of the work done at the Central Arid zone Research Institute over the last two decades. However, the weaker "wedding links" between the technology and production in the region are not hard to be located. As a step towards bridging this, gap the Institute launched an Operational Research Project and the development programme for sand dune stabilisation; pasture, grasses and forage development; afforestation and shelter belt programme; demonstration of higher productivity of improved technology on rabi and kharif crops; demonstration of higher productivity by improved technology of important vegetables and fruits; demonstration of effective control of rodents; community organization and programmes of technology; sheep development programme and demonstration of gobar gas plants, solar water heaters, solar dryers and solar cookers, have been taken up. The programme has revealed encouraging results. Additionally, for the quick transference of technology, the Institute organizes farmers' days, field days and provides literature in local languages to the farmers.

DR. SWAMINATHAN HONOURED

Dr. M.S. Swaminathan

Dr. M.S. Swaminathan, Director General, Indian Council of Agricultural Research (ICAR), has been elected Foreign Associate of the National Academy of Sciences of the United States, the highest scientific organisation in the USA. Dr. Swaminathan, who had earlier been elected a Fellow of the Royal Society of London (FRS), is the only Indian Scientist who has been honoured so far both by the Royal Society of London and the US National Academy of Sciences.

Dr. Swaminathan is the third Indian Scientist to be elected as Foreign Associate of the US National Academy of Sciences. The other two Indian Scientists—Dr. V. Ramalingaswami, Director of All-India Institute of Medical Sciences, New Delhi, and Dr. D. Lal, Director of the Physical Research Laboratory, Ahmedabad, had been elected in 1973 and 1975 respectively.

Dr. Swaminathan has been chosen for his outstanding contributions to applied genetics and biology.

Dr. Swaminathan was elected a Fellow of the Royal Society of London in 1973. He is a Fellow of the Indian National Science Academy, and the Indian Academy of Sciences and a Honorary Fellow of the National Academy of Sciences of India.

Dr. Swaminathan has been the recipient of several scientific awards, including the Shanti Swaroop Bhatnagar Award; Birbal Sahni Medal of the Indian Botanical Society; Mendel Centenary Award of the Czechoslovak Academy of Sciences; and the Silver Jubillee Commemoration Medal of the Indian National Science Academy. In 1971, he was awarded the Ramon Magasaysay Award for Community Leadership for his contributions as "Scientist, educator of students and farmers and administrator responsible for generating a new confidence in India's agricultural capabilities."

The membership of the National Academy of Sciences of the United States is offered purely on the quality of scientific work and its utility to human welfare, and is considered one of the highest honours and recognitions of the achievements of scientists. All the Nobel Laureates of United States of America are members of the Academy.