water tables causing spread of salinity/alkali problems in other areas, negative effects on excessive use of fertilizers and plant protection chemicals on water and environmental quality and a reduction in the bio-diversity. In the rainfed areas, acceleration of processes of erosion of surface soils is leading to reduced soil productivity, siltation of reservoirs and increased runoff-related adverse effects. In future, the technologies must result in increased productivity levels and ensure that the quality of natural resource base is preserved and enhanced.

- Our past research and development efforts to increase production focused on use of inputs for maximizing production. This focus will now have to shift to increase the use-efficiency of inputs for optimum and sustained production.
- New technologies are needed to push the yield frontiers, utilize inputs more efficiently and diversify to more sustainable and higher value-cropping patterns. These are all knowledge intensive and would require not only a strong research and extension system and skilled farmers, but also a dynamic interface for regular exchange of information, bringing advantages to all.
- These new approaches will constitute a distinct departure from our past approach of developing and promoting a set of recommendations where farmers were conceived as passive receivers of technologies and not ones who have a large reservoir of knowledge upon which the scientists needed to depend. This approach must now change. Farmers must have access to information based on sound science, which will help them take right decisions on how best to use management options in an efficient and effective manner.
- Most of our research programmes are currently organized either with a commodity orientation or address issues in a disciplinary manner. Scientists from different disciplines/areas must come together as a team in a 'problem-solving mode'. For generating future technologies, our knowledge base has to be much wider and deeper. This will call for bringing in the best of science to bear upon the process of technology generation. These inputs can be available from within the country through institutional linkages and must extend to institutions which are traditionally not agriculture related.
- There is a compelling need to understand and anticipate the challenges and opportunities in agriculture and agricultural research and development to be unleashed by the processes of globalization and to articulate a strategy by way of response to those new developments. An important consequence of these changes will be necessity for the scientists to work in partnerships: numerous, diversified, innovative and more substantive than in the past to avail opportunities for greater synergies, complimentarities and closer working relationships leading to reduced overlaps, less redundancy and effective and efficient use of limited resources.

To successfully meet the challenges posed by complexity of the problems facing Indian farmers and Indian agriculture, the community of agricultural scientists will have to change the way they identify and prioritize problems and the way in which they seek solutions and adoption of new technologies. Problems facing poor farmers must be conceived in totality and solutions attempted keeping a system's perspective in view, such that chances of finding appropriate solutions are high. Team work will be a necessity. Scientists from basic sciences will need to be increasingly involved in advancing the frontiers of knowledge, which will have a bearing on solving agricultural problems of the country. Advances in remote sensing and computer-based technologies, geographic informative system, communication skills involving networking, etc. will need to be routinely used.

To conclude, India's agricultural research and education system has grown to be large and varied over the past decades. The changes needed to make the system responsive to the needs of this century call for a fundamental change in our thinking and approach – a new paradigm. The changes will need to be conceived and implemented in the perspective of a vision of the future and a road map carefully weighing pros and cons of each step. To move in this direction the system needs to have in place mechanisms to think and change directions. As of now these mechanisms do not appear to be in place.

I. P. ABROL

Centre for Advancement of Sustainable Agriculture,
C-9/9564, Vasant Kunj,
New Delhi 110 070, India
e-mail: iabrol@vsnl.com

Earthquake observation

I was in Gujarat for about a week with a team of eight young doctors to offer succour and solace to the earthquake victims in the Kutch region. A confused opinion of the scientists and perhaps(!) overemphasis on the quake-resistant structures to mitigate such a disaster reported in the print media provokes me to give a brief account of my observations. I neither have resources and training to provide a technical report nor was the survey our mission. However my observations, though put naively in this note may benefit the experts.

We hired a Tata 407 that served as a mobile hospital-cum-shelter for us. Inspite of the hardships and strenuous journey across the Kutch from Bhuj, Anjar, Bhachou to Gandhidham, the young doctors were willing to serve the affected villagers in the interiors. We went up to Veera near the sea-shore on one side, and Kankhoi and Ekalma villages near Rann of Kutch on the other.

We stayed at Kankhoi (Bhachou Taluka), and strayed 8–10 km into the Rann. Typical observations are as follows:

1. Destruction in Bhuj and Gandhidham is qualitatively different than in Bhachou, Anjar and Ratnal. Bhachou in particular looked as if some of the buildings may have sunk into the earth, while many dwellings moved away and collapsed. Demolished structures looked as if they had been ground. It was notable that irrespective of the size, shape or the construction material, all structures were destroyed in this region.
2. Half of Anjar, Bhachou and the villages near Chobari have a similar pattern of destruction.
3. About 4–5 km from Kankhoi in the Rann, we found psi-shaped fissures on the surface, a few inches wide and few meters long, though not very deep.
4. There is practically no damage to trees and crops all along, and hardly any impact on the sea-shore we visited. Villagers told us that in the past there was an earthquake when trees got uprooted but buildings were not damaged. If true, this is surprising, and merits attention.

Seeing the pattern of destruction, it seems that Bhachou and similarly ruined towns/villages not only experienced jolts from the earth movement; there may have occurred fissures in the earth as wide as a few meters and tens of meters deep. A possible cause could be a belt of shallow or hollow tunnels beneath the earth surface in this region. Obviously relocation of the villages would be necessary rather than going for quake designs. In Ahmedabad and Bhuj, strong ground oscillations appear to have been dominant, as we gathered from the vivid narrations by the people. Here, efforts to build earthquake structures would be important.

Experts say that fore-shocks and after-shocks are normal. It would be better to analyse such data of minor tremors instead of making general statements. Immediate installation of seismic activity sensors/detectors deep inside the earth at Bhachou and continuous monitoring of the intensity and duration of the tremors there would provide useful information to understand the mechanism of the earthquakes. I appeal to scientists to act as fast as possible.

S. C. TIWARI

1 Kusum Kutir,
Mahamanapuri,
Varanasi 221 005, India

Public policy for natural hazard management

In the last decade four disastrous earthquakes (1991 Uttarkashi, 1993 Latur, 1999 Chamoli, 2001 Bhuj) and two extremely destructive coastal storms (1998 Kachchh and 1999 Orissa) struck the Indian subcontinent. But we did not learn any lesson on hazard preparedness. With all the determination and capabilities we, the governments and the people of India, have failed to cope with the variety of natural hazards that strike India relentlessly year after year. There is therefore a need for addressing the problem squarely and systematically.

Public policy for natural hazard management should include landuse classification, building codes, capital investments by governments, public information, education and warning.

Policy plans include formulating and enforcing laws and regulations for preventing or restricting development and use of the lands prone to hazards as indicated in the hazard-zoning maps. Since preventive and restrictive measures have proved ineffective in India, the most effective way of curbing the tendency to occupy hazardous tracts would be to impose a series of disincentives such as (i) denial of government assistance for development of roads, hospitals, schools, etc. in the identified hazard-prone areas, (ii) non-availability of loans from banks, (iii) denial of essential supplies such as water and electricity, and public services such as communication lines, sewer system, bus service, etc. and (iv) denial of insurance against hazards, natural or man-made.

Alternatively, the government can acquire the areas for alternative landuse such as recreation parks, wildlife sanctuaries, afforestation or allowing the original owners to pursue agriculture but forbidding construction of buildings, etc. In this way productive use is made of the land that is in short supply while the degree of risk is reduced.

A distinction must be made between a critical structure and an ordinary structure. A critical structure, such as a nuclear power plant or high dam, is one whose destruction or severe damage by a natural disaster would cause such extensive damage that it should not be built even if the chance of hazard is relatively small. An ordinary structure (e.g. building or a bridge) might fail or cause property damage or loss of life but the destruction would not be catastrophic.

There is also a need for legislation for mobilizing financial resources for monitoring, research and management of hazards.

Formation of a national commission (which might be called the Natural Hazards Management Commission (NHMC) is necessary to provide the community with all information relating to vulnerability of the areas to hazards, extent and magnitude of risks and likely impacts, and the mitigation measures to be taken up in time. This can be conveyed through periodic bulletins on hazards or other media containing all the information, including the hazard zoning maps. The Commission would plan and coordinate the efforts of different government agencies and voluntary organizations mobilized to cope with hazard, relief and rehabilitation. It