Science and its applications to societal security

Ashok Parthasarathi

Humankind emerged from the Second World War with the greatest accumulation and applicability of science and technology in history. But the end of that 'Hot War', saw the emergence of a 'Cold War'. The engine of its arms race were scientific discoveries in nuclear science, engineering and electronics converted into a range of weapons and weapon delivery systems, and, paradoxically, the means to detect and destroy them through a plethora of revolutionary counter technologies.

In parallel, another unprecedented development was unfolding: the decolonization of over 100 countries – what became 'developing countries', or 'the South'. Most of their first-generation leaders – Nehru, Tito, Nasser, Sokarno, Nkrumah, Castro – launched major efforts at nation-building encompassing social, economic and cultural development, often under radical conditions. But when it came to 'security', it was a different story. Traditional British or European standpoints viewing security synonymously with *Military* security – often, more narrowly to 'defence – came to be adopted.

It was the USA which broke fresh ground in this arena, with a broader formulation called 'national security' – of which military security was only one, albeit an important component. Its National Security Act of 1947 defined security so all encompassingly that non-military threats to food security, health security, nutritional security, ecological security, and energy security – the last a crucial underpinning of the rest – come about naturally. The 57 years that this Act has been in force, has seen successive US governments interpreting national security in wider and wider terms – both defensively and offensively. For example, food security covered not just the techno-economic availability of an adequate range and quantum of *food for their own* populations at low prices, but equally, to use the *sale of food to other countries* as a political, diplomatic and foreign policy weapon. Such a weapon was used against not only their main adversaries during the Cold War, but also many non-aligned countries[1,2].

We in India came to appreciate the true import of this during the mid-60s, when for three successive years, our food-grain production failed due to bad monsoons – our agriculture still dependent on rain-fed growth of traditional seed varieties. This forced us to import, principally from USA, 12–15 million tons of wheat during each of those years. For perhaps the first time, we faced a challenge to our physical food security on such a scale. Recognizing our vulnerability the US President and the World Bank's head pressurized our government tremendously for quid pro quos of various kinds for supplying the wheat we so desperately needed.

However, C. Subramaniam our dynamic and able Food and Agriculture Minister went to Washington, and after protracted negotiations secured the requisite supplies without making major concessions. But the whole process had a traumatic effect on our nation and its leaders. I still remember Subramaniam telling me on his return from USA in 1965: 'In the memory of my father I swear, that no Agriculture Minister of the government of India will be subjected to the pressures and threats, that I have had to endure during the last 10 days'.

Having so tied up the short-term supplies of wheat, Subramaniam – who, unlike other politicians, understood the dynamics of science-based agriculture – formed a team for the medium-term task of steeply and quickly increasing domestic food production. *This team consisted of an able administrator B. Sivaraman, Secretary, Agriculture and two leading agricultural scientists B. P. Pal and M. S. Swaminathan.* With strong political and governmental backing by Prime Minister Indira Gandhi, they drew upon the high yielding varieties (HYVs) of wheat seed – developed by Norman Borlaug at the International Wheat Research Institute in Mexico – to bring about the now famous Green Revolution. By 1975–76, a decade later, our country became self-sufficient in food grains[3].

Through sustained and deepening R&D in both the types of crops and their appropriate agro-climatic regions, food production has increased steadily from 1975. A combination of the application of science and technology and effective agricultural planning and administration, has realized and sustained a steadily growing output – even during monsoon failures and other adversities impacting traditional agriculture. But today we face a different problem, viz. 'buffer stocks' over the last five years have reached the astronomical level of around 60 million tones. On the face of it, this has made the nation secure in the *physical availability* of food-grains. However, because the HYV-based agricultural strategy of the last 35 years got progressively capital-intensive and less labour-intensive, and because rural employment generation programmes have generally not succeeded, today we face an acute *economic food insecurity*. This affects about 300 million people living below what we call 'the poverty line'.

The challenge therefore is to use some 15–20 million tones of buffer stock to develop large-scale food-for-work programmes in rural areas, with special focus on building the desperately needed rural infrastructure. An excellent example of this would be the construction of a large grid of silos, using labour-intensive techniques, to store the buffer stock. Proposals have been put forward to the government and some action is already underway. However, much remains to be done, and done quickly. In tandem, we need to intensify major ongoing R&D programmes to *increase the yields* of grain, horticulture, and pisciculture-based production, as current yields are way below even those of China, let alone those of the industrialized countries. The development and large-scale application of improved and new technologies in this field are crucial to maintain and enhance our food security over the next decade[3].

In health security, our record is poor compared to the successes in the Green and White revolutions. We may recall that immunization was one of the technology missions of the Rajiv Gandhi government. We had even then requisite disease preventive/eradication vaccines for most communicable diseases. Yet, policies and administrative failures led to a situation in which, except for smallpox and to a large extent polio, other scourges – tuberculosis, cholera and typhoid, to mention a few – still afflict our population. The Department of Biotechnology has a major Vaccine Action Programme to develop newer and better vaccines, particularly for the renewed incidence of diseases' whose carriers have become resistant to earlier vaccines. What scientists and technologists have to do, and do quickly, is to replicate the success of the hepatitis vaccines based on genetic engineering techniques developed by the highly innovative firm, (Shanta Biotech, Hyderabad). But immunizing our entire population against the 9–10 major communicable diseases, is as much an administrative and logistical challenge as a scientific and technological one. In my opinion, now the ball is in the court of politicians and administrators[4].

The condition of malnutrition, common among the urban and rural poor, particularly new-born babies, and nursing mothers exists on two counts: in part due to the widespread prevalence of intestine-related communecable diseases, and in large part due to a forced inadequacy in nutritional intake. Clearly, calorie malnutrition, anemia, iodine deficiency, etc. especially in pregnant and nursing mothers, are again more administrative than scientific problems. The Central and State governments ought to visualize and operationalize an integrated view on their food and nutrition programmes. One way could be by planning a massive micronutrient input system which includes iron, folic acid and low iodine correction food supplements. There is of course a national programme of nutritional upgradation for the vulnerable sections; but here again, the reach, intensity, coverage and regularity of the administrative systems involved leave much to be desired[3].

The point I am emphasizing is that to achieve nutritional security we need a combination of the achievement of *both* food security and health security, as discussed above. Such an integrated vision is equally required to address ecological security. The large-scale and sustained use of inorganic fertilizers and crop-protection chemicals which formed the bedrock of the classical Green Revolution, has led to widespread pollution of the soils and groundwater. There was also definitive evidence, at least by the late 1980s, that the substantial per hectare yields in the core areas of the Green Revolution had begun to decline. Furthermore, the pest resistance of Green Revolution crops also started declining, as pests became cumulatively resistant to first-generation pesticides and second-generation crop-protection chemicals. This had influenced agricultural scientists to start work, almost 15 years ago, on eco-friendly, high-yielding crop varieties. The objective was, what Swaminathan termed, the conversion of the Green Revolution into an Evergreen Revolution[4]. But as it stands, the proliferation of the classical chemical-based Green Revolution is fast becoming a serious threat to our ecological security.

Looking at natural resources in general brings us to energy security, a core area of national security. Not everyone may recall the crude oil price-hike of mid 1973, after the second Arab–Israel war – the price of a barrel of oil rose from US $ 20 to US $ 40. This caused massive problems for dominantly oil-importing countries like ours, dealing a body blow to the dynamics of our balance of payments. Interestingly, the then government had designed and successfully executed a two-pronged response. First, a 'crash programme' to increase domestic crude production levels by 4 million tons between 1974 and 1976 – a 20% increase. Concurrently, it implemented a major programme for export of complete projects (in housing complexes, railway lines and power plants), combined with design and engineering services in these areas, plus those relating to the petroleum industry. This was targetted at Iraq, Algeria, Kuwait and Iran – to substitute such services hitherto imported by them from the West – to pay for our crude imports. This effort – in terms of the level and range of expertise of our scientists, engineers and managers and capital-goods industry involved – has not received the attention and appreciation it deserves. This is a shining example of how our S&T capacity significantly enhanced the nation's energy security during the troubled 1970s. When the Congress was voted out in 1977, its Finance Minister – C. Subramaniam of Green Revolution fame – announced that he was handing over to the Janata government foreign exchange reserves of US $ 4 billion.

Due to our oil exploration and production programme from 1975 onwards, by 1987 our oil energy balance stood at 1/3rd import and 2/3rd domestic. Ten years later, however, the ratio had reversed. The government is mounting a multi-prolonged strategy to develop onshore and offshore oil and gas resources, including taking stakes in fields in foreign countries; as also, building large-scale infrastructure for nation-wide gas supplies through giant projects such as PETRONET.

Nevertheless, much remains to be done in at least two areas of enhancing energy security. The first, to extend the programme on renewable energy of all kinds, particularly in rural areas to substitute kerosene and diesel. The Renewable Energy Policy of 2004 targets to expand the installed capacity from around 4000 MW to 12000 MW by 2012 – 6% of the total projected installed electrical energy capacity by that year[5]. This is an entirely achievable objective provided the scientific, technological, economic and institutional aspects are synchronized, and this programme is undertaken in mission mode. The second is to effectively design and implement a strategy, policy and set of practices for energy efficiency and energy conservation in all areas, be they coal, oil/gas or hydro-based; be they related to agriculture, industry or transportation. This calls for tough measures which the industrialized countries, and Japan in particular, mounted after the oil crisis of 1973. It calls for an integrated drive for energy efficiency and conservation – in building design and construction, manufacturing plants and, above all, transportation, especially the railway and automobile subsectors.

Jawaharlal Nehru once said, 'Scientists are a minority in league with the future'. Today, we must rejuvenate the spirit behind this in terms of what scientists and engineers could do to enhance the nation's development and security – and in the latter, minimize both military and non-military threats to our societal security.

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3. The Alma Ata Declaration, World Health Organization, Geneva, 1980.
4. Swaminathan, M. S., The Ever Green Revolution. Keynote address at the celebration of 35 years of the Shastri Indo-Canadian Institute, New Delhi, April 2004.
5. Ministry of Non Conventional Energy Sources, Government of India, March 2004.

The author is in the Centre for Studies in Science Policy, Jawaharlal Nehru University, New Delhi 110 067, India. e-mail: aparthasarathi2002@yahoo.com