AGRICULTURAL RESEARCH AND EDUCATION IN THE CHANGING WORLD ORDER*

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It is a matter of great pleasure for me to be here to attend 49th Conference of ISAS and to deliver the 32nd Dr. Rajendra Prasad Memorial Lecture. As President of the society, I feel privileged to address this august gathering.

Changing Agricultural Scenario

Since ages, agriculture sector has continued to be the backbone of Indian economy. Even today, the sector contributes 32% to the GDP with 70% of the country's population engaged in agriculture, as compared to 2-7% in the contemporary developed world. Fortunately for us, the agricultural production has kept pace with the population growth rate of 2.1% per annum. Compared to 51 million tonnes of food grain production in 1950-51, India realised foodgrain production of 192 million tonnes during 1994- 95 resulting in a buffer stock of over 36 million tonnes, which is a befitting compliment to agricultural development in our country. Even in the oilseed sector, which is primarily rainfed, we have had a spectacular achievement where exports of oilmeal and minor oil is now twice the amount of the ever highest import bill on edible oil. Developments in horticulture, livestock, milk, fish and poultry production have also been of a high dimension. Even though we have moved a step forward towards incorporating the genes of sustainability in agricultural production, the vast agricultural potential still remains to be harnessed.

While the process of consolidation of the green revolution continued in the eighties and nineties, research was strengthened in the field of pulses, oilseeds, integrated pest management, conservation of natural resources and their effective utilization. The process of rural development through various integrated rural development programmes continued to spread and reach the small and marginal farmers, agricultural labourers, rural artisans, weaker sections of the society and even the rural women. The results were encouraging and absolute poverty level started declining systematically. The nineties have brought into focus the twin objectives of enhanced productivity and sustainability.

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The continuing population pressure in the country will demand substantial increases in food, feed, fodder, fibre and fuel production over the next few decades to be able to maintain self-sufficiency and also to meet export requirement. It is expected that our foodgrain requirement by the year 2000 AD would be about 210 million tonnes (mt). The National Commission of Agriculture (NCA) had set a target of 37 mt of oilseeds, 32 mt of sugarcane, 180-190 bales of cotton, 45 mt of vegetables, 30 mt of potatoes, 3 mt of onions and 20 million coconuts. These considerations along with a declining soil-resource base available for agriculture which is expected to be only 0.15 hectare per caput in 2000 AD, the pace of soil degradation that is taking place now, the imbalances in regional productivity and environmental concerns of high input intensive agriculture are some of the background issues in developing future research strategies for sustainable resource management.

The livestock provides milk, meat, eggs and industrial raw materials such as fibre, skins, hides, and farmyard manure. India ranks second in the World in milk production. The National Commission on Agriculture had visualised the production targets of milk, wool and eggs at 64.4 million tonnes, 52.5 million kg and 36,000 million respectively (achieved 60.8 million tonnes milk, 42.2 million kg of wool and 24,000 million eggs) to meet the requirement of the soaring human population of 990 million by 2000 A.D.

The contribution of livestock sector has assumed appreciable dimensions in the country's agricultural economy. According to approximations of Normal Accounts Division of the Central Statistical Organisation (CSO), the gross value of output from livestock at current prices was about Rs.588 billion (1992-93) which is about 26% of the total value of agricultural output. This excludes the contribution of animal draft power.

The agricultural sector is witnessing fundamental major structural changes leading to liberalization of markets, export orientation, value addition and shifts in public - private sector balance. While self-sufficiency in our food supply and food security continues to be our primary goal, it is recognized that higher rates of economic development is feasible. There is increasing attention towards integration of agriculture education, research and extension with development tasks (more particularly rural development), integrating productivity advances with environmental concerns and conservation approaches. The large area under the rainfed sector, the predominance of small and marginal farmers and alleviation of rural poverty have to be taken into account in the developmental perspective since development problems of employment, entrepreneurship, women in agriculture also became important elements in a controlled change.

The present represents a transition period and we have to adjust to the consequences of changing policies. The public, private and voluntary sector efforts in research, education, extension and training need to be complemented and integrated for a more harmonious rural development perspective. Apart from basic sciences, applied sciences, life sciences, processing, marketing, consumer concerns on quality, off farm resources, costs, skills, integrating physical farming part with post harvest human uses and impact.

Therefore, the task facing us today is achieving sustainable nutrition security, which involves physical and economic access to balanced diets and safe drinking water to all citizens. Only nutrition security at the level of individual households can ensure that children have an opportunity for the full expression of their innate genetic potential for physical and mental development.

Obviously, there is no simple or single solution to the complex ecological, socio-economic and technological problems facing those engaged in promoting sustainable advances in the productivity of terrestrial and aquatic farming systems. I can see no way of facing the scientific challenge except through accelerated efforts in the blending of traditional wisdom and technologies and modern science and technology. The new technologies of particular interest to agriculture are biotechnology, information technology, space technology, micro-electronics and management techniques.

In this context it is human capital, through the use of science and technology, that drives the system for enhancing productivity from land, labour and total factor productivity. In view of the holistic and inclusive nature of agriculture closely tied up with rural development and an international perspective, it is necessary to analyze the changing human capital needs. Agricultural careers will now extend beyond farming and a multiplicity of options will open up. Besides agricultural production related activities opportunities will abound in agribusiness and agro-industry related fields.

Socio-economic, equity and gender considerations will be the major guiding principles along with productivity and sustainability considerations.

Agricultural Research

India has now nearly 100 million operational holdings. 25% of the world's farmers are in India. India has also 20 percent of the global farm animal population. At the current rate of population growth, India will have over 1000 million people at the beginning of the 21st century. Compounding the problem of increasing economic marginalisation of the rural and urban poor, is the growing damage to the ecological foundations essential for sustainable

agriculture. Over 100 million ha of potential farm land have undergone varying degrees of degradation. Even now, there is no policy for preventing the diversion of prime farm land for non-farm uses. The same is true of groundwater resources which are often being exploited in an unsustainable manner. Habitat destruction is leading to the loss of biological diversity. Protecting the already protected areas is proving to be a formidable task. In intensively farmed areas biotic and abiotic stresses are increasing.

The challenge before scientists, political leaders and farmers is-how can agriculture yield more food, jobs and income in rural areas under conditions of shrinking land and fresh water resources, expanding biotic and abiotic stresses, loss of biological wealth and potential changes in climate, sea levels, and ultraviolet-B radiation?

We have come a long way starting from Pusa in 1905, the then Imperial Agricultural Research Institute, to the present day ICAR. Presently, the National Agricultural Research System (NARS) has 49 Research Institutes, 30 National Research Centres, 10 Project Directorates, 78 All India Co-ordinated Research Projects/programmes. In agricultural and extension education together, we have 10 institutes/academy/national centres/programmes. Thus, the Indian Council of Agricultural Research has 194 research establishments directly under it. In addition, there are 28 State Agricultural Universities and one Central Agricultural University in the North-East.

Institutional set up with need-based orientation and adjustments, commensurate research, personnel and financial policies and appropriate research management systems, where each element moves in harmony to deliver its best to attain and sustain the highest possible results within a given time scale, would be desirable. The first step in this endeavour would be to set up a demand -driven research agenda, institution, region, crop, commodity and discipline-wise on a perspective plan basis with required amendments in policies-personnel, physical and financial. To keep up with the pace and to be competitive nationally, regionally and internationally, frontier areas of technology would require pin-pointed attention.

On a changing time scale, the system will have to be dynamic to exploit opportunities by using natural endowments on a sustainable basis. The conceptual model of deriving the best out of the vast resources, viz. scientific, technical, ecological and environmental, will have to be judiciously used and managed in a way that these are in harmony with the environment. Sequentially, next issue required to be addressed is, who is expected to do what, how and when and what resources would be required keeping in view the sustainability

of the productivity system on a long-term basis. Goal setting and establishing priorities - issues related to productivity and sustainability, environmental concerns; conservation of biodiversity and natural resources management; facing global climate change; value addition' post harvest activities and agro industry; biomass, renewable energy and managing agricultural wastes; competition, markets, exports, consumer quality; social aspects of development, etc.

Traditional technology has involved not only the production of hybrid plants through selective breeding but also technologies involving irrigation, land preparation, post-harvesting methods, as well as fighting and eradicating diseases affecting plants. The integration of all these was necessary for the green revolution to have succeeded. Extension services, programmes such as 'lab to land' and marketing cooperatives have played very important roles as ancillary features of traditional technologies.

One might expect frontier biotechnology to be based largely on the manipulation of genes. Transgenic plants and transgenic farm animals have been achieved in several instances, mostly by manipulating these at the cellular or tissue level rather than the whole organism level. Frontier technology involves non-agricultural end-uses of plants as well. The manufacture of human antibodies and immunochemicals from plants has been a dream that appears close to realisation.

Another technology which will become increasingly important in the post-GATT era is the genetic fingerprinting or the DNA profiling of plants, seeds, animals and other economically important life forms, such as silkworms or even wild life. The need for and the importance of DNA profiling has been keenly realised in many countries. The ICAR and the NDRI have both collaborative programmes with the CCMB, Hyderabad in the utilisation and application of DNA fingerprinting technology using multi locus and single locus probes for identifying organisms of agricultural and farm interest.

The relevance of improved agricultural technology increases when farming systems perspective is perceived and in- built into the technology generation process by the various component research groups. Apart from bio-physical and environmental consideration, issues concerning socio-economic factors, farmers' perception and policy aspects need to be addressed in developing appropriate technology suited to each agro- ecological region. Technologies generated into this underlying concept will ensure dovetailing the short-term gains of enhancing farm productivity and income with long-term insurance of minimizing natural resource degradation and enhancing societal benefits. Thus farming systems research will provide the connecting link between the scientific

groups to visualize the real world problems on one hand and the development groups on the other to assess the impact of the technology and provide the necessary feedback for refinement of the technology. Participatory rural appraisal and on-farm operational research on total production technology package will form the modes of earning out of the farming systems research in each eco-regional unit.

Even if the ultimate irrigation potential of the country is realized, about 50% of the cultivable area may continue to be rainfed. Since vagaries of weather affect production from drylands and thereby the stability of the food production in the country, strategic research on rainfed agriculture may be a priority area to insulate the farmer from high risk-proneness of dryland farming. The thrust areas of research will be - a detailed resource (land, climate and water) characterization to optimize land use for rainfed crops and other alternate land-use systems, understanding of crop-weather-soil relationship for providing better agro-meteorological advisory services, rain water conservation and integrated nutrient management. These would need concerted research and development efforts.

In order to achieve the estimated production targets and productivity of livestock products, an integrated research effort in animal breeding, nutrition and physiology, health and animal products technology would be required. The major thrust is and will continue to be on improving productivity and efficiency of production through solving problems of adaptation, reducing mortality and morbidity from diseases and efficient handling of animal products.

Apart from the traditional export items, value-added products have got greater scope. In grapes there are excellent high quality varieties for export. These are being used to produce champagne. High quality raisins are also produced in large quantities. The essential oils and oleoresins from spices like pepper, ginger, chilli, cardamom etc. are also gaining importance in the export trade. Development of varieties which can give sizeable quantities of value-added products having high export potential are also important.

Sustainable agriculture will be possible only with location- specific technologies. This in turn will call for the wise use of biological diversity. However, unless a pro-poor bias is imparted in technology development and dissemination, resource poor farm men and women will derive little benefit from the onward march of science, particularly in the area of bio- technology.

Most of the agricultural research in the developing countries like India is being done by the government organizations unlike the developed countries

where a significant share of applied R&D is in the hands of private sector. The public sector organizations do not sell the technology or the research outputs but by way of extension programmes provides it free to the farmers. It would be desirable if provisions of limited commercialization are included in the mandate of the research institutes so that they can, in part, generate their own resources. The research institutes for instance should take lead in the field of producing and marketing the seeds of improved varieties. The regulations imposed under the GATT agreement and coming into force of Intellectual Property Rights and patenting of the plant material, arrival of Multinationals in agriculture, particularly the seeds, could make difficult the availability of planting material at affordable prices for farmers. The research institutes could therefore step into supply of improved seeds at minimal profits and help to control the seed prices. The institutes should now come forward also to undertake contractual research funded by the other agencies. The concept of revolving fund schemes currently in operation in India should be further proliferated. The Council had constituted a committee to formulate guidelines on issues related to Public-Private sector, linkages, resource generation, training, consultancy, contract research/contract service and Incentive and Reward systems. In other words, an element of commercialisation needs to be injected in the public sector agricultural R&D so as to improve its efficiency.

Domestic situation with regard to agricultural, particularly food crops production, in most of the countries of the region as well as the emerging world economic order necessitates a fresh and comprehensive look at R&D priorities in agriculture. The foregoing articulation of challenges and the obvious inadequacies in NARS make this quite clear. Ideally, such exercises should include not only the agriculture sector (defined narrowly in terms of crops, livestock, fisheries, forestry and natural resources), but also other sectors which influence and are influenced by agriculture. These linkages have assumed more importance in context of the globalization.

The NARS must respond to the IPR and patenting imperatives thrown up by GATT. This is a difficult area with politico- economic overtones and inherent contradictions. But these must be resolved.

India possesses one of the largest and most complex public systems for the generation, testing and transfer of agricultural technology. The public sector research and technology transfer system have been highly effective in introducing the green revolution technologies to farmers, particularly in well-endowed areas. But the overall efficiency of the system is rather low. Moreover, the technologies have been less successful in poorly endowed area and several second generation problems, specially unsustainability, have

emerged. Technical solutions to these new challenges are expected to be more locally based. Their solution will depend on a system approach and requires a bottom-up response to the demands of technology users. Closer interaction between research, extension and farmers through participatory approaches will be needed.

Technology transfer, in order to be effective, must be preceded and succeeded by technology assessment. How reliable has the assessment been can be judged by the effectiveness of transfer of a given technology. Therefore, technology assessment and technology transfer are complementary to each other. Technology transfer must be based on needs and capabilities of agro-ecological settings, resource endowments, agro-production and distribution systems and farm-households.

The role of extension functionaries at various levels have undergone significant changes. Measurement of outputs in terms of visits, training conducted, persons contacted do not correlate with production/productivity changes. A clearer role definition and job description of the extension hierarchy is essential. The tasks, outputs, outcomes need to be defined in precise and measurable terms to establish accountability. A mission oriented approach targeted to specific groups/problems with limited tasks at a time and measurable outputs is essential. This will facilitate matching training and tasks.

The extension functionaries also need to have adequate understanding of the output side of the production system. Extension needs to be like a small business programme. The functionaries need to be equipped with certain fundamental ingredients like - problem solving abilities, innovation, entrepreneurship, pool of business skills, leadership, infrastructure and financing.

Besides transfer of technologies, agricultural extension deals with several support subsystems, inputs, credit, markets, regulation, information processing, etc. The extension services enlightens the farmers on contemporary developments in agricultural technology, provides technical services, ensures availability of required inputs and widens the horizons of the farmers and their perspective of the production system.

The equity, social and economic justice and harmonized normal and sustainable curve of growth would be expected only with well thought off and well planned and executed research and development strategy. The strategy must rally around the conservation of natural resources-soil, water, vegetation, solar energy, etc.- so that these are available for their rational use on sustainable basis.

Whichever way one approaches the problem, the end-user is the farmer,

the cowherd and the livestock breeder. Technology needs to be packaged to these end-users in a fashion that is not intimidatory but user-friendly. Even as technology moves from the traditional to the frontiers, this invariant condition needs to be met. India's malnutrition problem thus became largely one of under-nutrition or calorie deprivation. It is estimated that over 200 million children, women and men living in poverty now suffer from chronic hunger. While famines have been avoided, chronic hunger persists and without jobs for all, this problem cannot be solved.

Human Resource Development

Human Resource Development, particularly in the frontier areas of technology, is considered crucial to meet the changing research and educational needs. In the frontier areas of technology generation, a blend of new and experienced scientists would be required. In this endeavour, training, visits within India and abroad, would be essential. This would call for adequate resources to ensure that such activities are undertaken depending on the need. Provision of sabbatical leave would be crucial to ensure that scientists avail of the facility to have innovative thinking in order to meet the specific issues. Similarly, redeployment, readjustment and transfer of scientists and officials would call for an effective policy to meet the research and developmental requirements.

There is an incredible variation in human capability both physical and mental. Equally incredible is the degree to which an individual or group can evolve or degenerate based on the effort put in the process. This simply underscores the need to develop the human resource irrespective of the area of activity which infact is a management tool equally applicable in Agriculture Science as it is in other disciplines. All management tools are neutral and can be applied equally to business, industry, agriculture education and even to a considerable extent to individual and domestic needs with profitable results. Only the methodology and the technique of their application and the degree of applicability would change. Science because of the subtility of its nature requires considerable sophistication and refinement for these processes to yield tangible results. For that very reason it requires a vision and a well directed mission to this charter for desired development and a fruitful change.

The change due, either, to the stimulus of external environment or to the internal pressure, cannot remain static in any dynamic system. The only alternative to change is decay. Any vibrant forward looking organisation sensitive to forces of change impacting on it has to have a set of integrated and interrelated initiatives in HRD. The problem acquires complexity because

it is not only acquisition of simple skills but also knowledge, attitudes and more important of values. These together constitute the work culture of the organisation and the nation.

HRD is a necessary concomitant of all dynamic systems for stability and attaining equilibrium with external forces. Without HRD, organisations can't grow. Any diversification or an effort at renewal should be preceded by matching HRD initiative. All improvements in systems and services have to have a component of HRD. If the organisation wishes to assume leadership role it has no option but to launch comprehensive HRD programmes to match with these efforts.

One important aspect of the relationship between human resource development and the management of change is that the former must precede the later so that the qualified manpower is ready to develop and absorb the new techniques and technologies that are likely to be developed/introduced to avoid time lags. This requires foresight on part of the management to anticipate the degree and magnitude of the change either planned or spontaneous.

Training is a crucial and continuous requirement for agricultural development. Training needs, content, methodologies and approaches change with developmental phases, strategies adopted and clientele. Since education and training are powerful tools for technology transfer and agricultural development, training should find a higher place in the organisational agenda. Training should focus on practical and problem solving abilities and acquisition of skills for entrepreneurship and self- employment.

Agricultural Education

That the human capital in science and technology has to play a more significant role to achieve the desired results is also established. For this its commitment and contemporariness in content and quality have to keep pace with recent global developments in agricultural and related basic and social sciences. Reorganization of the Agricultural Education System in India, based on the land grant colleges of USA was initiated in 1960s bringing agricultural education, research and extension education under one umbrella. This marked a major conceptual change.

"Agricultural education is a profession oriented complex built on knowledge drawn from basic sciences, applied sciences most relevant to agricultural production, related insights from the social and behavioral sciences and the problem solving fields like natural resource management."

To ensure quality education and uniform standards, establishment of an

accreditation board is considerable ideal. Council is taking initiatives in this direction. Similarly, revision of course-curriculum befitting national requirements, are being undertaken to ensure that the education imparted is fruitfully utilised.

Information is knowledge and knowledge is an essential and basic capital. There is information explosion around the globe and our farmers and scientists have to keep pace with these developments. This is possible only if our Institutions are connected to international networking and have access to international data bases and information on emerging technologies. ICAR has undertaken an elaborate net-working plan involving NIC and ERNET and connecting ICAR Institutes, SAU's etc. with the objective of dissemination of information and sharing of knowledge. Knowledge is important but understanding is far more important. Job-oriented education is a priority but excellence promotion in frontier areas cannot be sidelined. Development of school of thoughts, establishment of centres of excellence, recognition to meritorious teachers imparting higher education etc. is receiving attention of the Council.

The urgent need in UG education is to enhance the skills and problem solving abilities, and one needs to examine as to how to accomplish this. There is a need for a new balance between breadth of discipline oriented studies and the depth of specialized skills and abilities. A broad based discipline oriented curriculum in the first two years and a specialized area in the last two years with emphasis on practice might be one direction. The integrated four year curriculum has to establish an appropriate balance between breadth and specialization; discipline courses vs. multidisciplinary courses; core curriculum vs. choice of specialization's, class room study vs. field/factory study. Conferring professionalism in a chosen area should be the main consideration. It has to be examined whether the rural development education could be integrated or a separate course needs to be designed.

The PG education and research cannot be viewed separately since the objective is to generate new knowledge and technology. The PG education should reflect the international and inter- institutional directions with respect to curriculum development; teaching capabilities in frontier and emerging areas; study abroad; research collaboration and linkages with national and international programs; multidisciplinary centers of excellence; faculty diversity and upgradation; an immaculate publication record in nationally and internationally known journals and awards and recognition for academic excellence.

The instruction is both science and art. The scientific side takes into account

the methodology and principles where as the art component emphasises on the management of motivation, learning of behaviour and personality of the teachers. A proper blend of both these components is essential to become a successful teacher.

The educationists have to realise that the significance of curriculum, which is dynamic in nature. Also, the present methods and techniques of teaching-learning should be so designed that they facilitate faster learning, and also help in keeping the rapid changes in science and technology.

There is also emphasis in the present curricula on preparing our undergraduates for careers in agriculture or agri-business outside government service. Also there is no readily available mechanism in the present HRD system to remedy this mismatch. Private employers often have to invest significantly both for the induction and on-the-job training of young graduates in order to make up for existing weaknesses of the educational system. Also there exists a imbalance relating to intake and human resource needs. Advance planning and students placement counselling is often lacking in most of the institutions, which need to be addressed on priority.

Inadequate opportunities for off-farm employment and inadequate attention to social organisation in rainfed areas with regard to saving and sharing water and to post-harvest technology, including biomass utilisation, led families without land or livestock or fish pond or trees remain under-employed or often unemployed.

Conclusion

Agricultural education and research are like two wheels of the same cart and are complimentary in their roles for the development of agriculture. It would be our constant endeavour to achieve excellence in both these fields so as to attain and sustain place of pride for Indian agriculture in the world, in the times to come.

For an effective management of change, integrated management of resources are considered vital. Problem-oriented, demand- driven, viable, sustainable and diversified system and situation- based matrix approach of integrated research and development involving all reasonable players as partners are believed to offer practical solutions. The essence of co-operation, removal of apprehensions and realization of strength, weaknesses, threats and opportunities leading to problem appreciation, commensurate programme formulation and ensuring harmonized is believed to benefit one and all.