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Presidential Address

AgrInnovation: Peasant to People

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AgrInnovation: Peasant to People

Agriculture dates back to over 10,000 years ago in the areas of present day Turkey and the Middle East, where evidence exists of people taking wild grasses and using the seeds for food and planting for the coming year's food. It is since then that the seeds of unbreakable relationship between agriculture and creativity were also sown. Over centuries, this complex agricultural production system has evolved with efforts of millions of farmers all over the world. Addressing the complexities such as harnessing the potential of available natural resources, maintaining the fertility of soils, protecting the crops from insects and pests, developing crop and animal husbandry practices and innovating a system to integrate, harvest, store and process the crop for food and feed would certainly have required constant innovations and decision making. Indian agriculture, from snow-covered Himalayas to deserts and coastal plains, provides a large and complex canvas for limitless experimentation, cross learning, as well as ideas from both agriculturists and those outside the domain of 'farming'. Being an agrarian economy, it is not uncommon to meet hundreds of countrymen, not into farming, but relating to agriculture, in a few minutes of interactions. From a no to agriculture, to having some introduction and then to relating to rural life in the earlier generations at home, it has been interesting to discover their child-like excitement towards agriculture. Several conversations have turned into how people, students, industrialists, data managers, software engineers, could contribute to enhancing agricultural productivity, through applications and interventions from their knowledge domains.

This Address also keeps in view the fact that presently we are in the decade of Innovation, 2010-2020, as declared by the Government of India, that formulated the Science, Technology and Innovation Policy in 2013, also integrating the policy for R and D in Agriculture developed by the ICAR. The goal of the policy has been defined as a strong and viable Science, Research and Innovation System for High Technology-led path for India (SRISHTI).

Changing Paradigms

The physical, social, and economic environment in which agriculture is being carried out today is dynamic and evolving in more unpredictable ways than ever before. The challenges that arise are not only unpredictable, but abrupt at times. While the one major task before agriculture sector is to increase the food production by 70% to provide food and nutritional security to the global population of more than nine billions by 2050 at the global level, equally daunting is to meet the expectation of the country where agriculture accounts for over 60% of rural employment and 14% of the GDP. Urbanization, globalization and market forces and their influence on patterns of consumption, competition, and trade are propelling Agricultural R and D and are also a major driving force for innovation and innovation systems. To provide livelihood security to the farmers, sustainability to agri-entrepreneurs / agribusinesses, and credible support to the national economy for competing in the midst of changes of this magnitude, we have to incessantly innovate. Experience shows that high returns and poverty alleviation have been achieved through opportune investments in agriculture research and development and appropriate linkages with extension services. However, this approach alone may not be enough for fostering innovations at the pace and magnitude required to mitigate proliferating challenges confronting the agriculture sector today.

It is a recognised fact that we have moved from the paradigm of Agricultural Research System to Agricultural Knowledge and Information System that lays greater emphasis on linkages between research, education and extension, with reference to the farmers' need for new technologies. At a time when farming is subject to unprecedented abiotic and biotic stresses as well as unpredictable trade and markets, realising higher input efficiencies, reducing costs of cultivation and enhancing farmers' income have become important, both for sustainable agriculture and retaining peasants in farming. Diversified and efficient agriculture, risk-proofed and remunerative, is the need of the day. In this context, innovation that is socially appropriate, economically beneficial and competitive assumes significance.

Innovation

Application of ideas, knowledge or practices that are new to a particular context, for creating positive change to meet needs, take on challenges or

seize opportunities, either substantial or cumulative, amounts to innovation. Application of all types of knowledge, insights and intuitions to achieve the desired social or economic outcome constitutes innovation. While scientific research generates knowledge, innovation converts knowledge into value and or wealth, by providing solutions. Learning the process and implementation of design and production of goods and services that are new to individuals or organizations with respect to their competitors, their country, or the world would encompass innovation.

Innovation could be incremental or radical; institutional, technological or social, depending on the context and further, pertaining to product, process, market, implemented by an entrepreneur or an organisation. Agricultural innovations are fostered in the interactions between production, trade and consumption; technology, information and knowledge; demands, attitudes and practices.

Innovation requires an ambience for problem identification, assessment of the available remedies and their incompleteness in providing a wholesome solution, interactions with non-conventional players, alternatives and their feasibility analysis, converting thoughts into a process / product, validation of the targeted action, scale-up and demonstration, as also appreciation from a peer group or the users.

Innovation System

An innovation system comprises the organizations, enterprises, and individuals that together demand and supply knowledge and technology, and the rules and mechanisms by which these different agents interact. The concept focuses not merely on the science suppliers, but on the totality and interaction of actors involved in innovation. It extends beyond the creation of knowledge to encompass the factors affecting demand for and use of new and existing knowledge in novel and useful ways. Hence, innovation in agriculture would entail implementation of new or improved products, processes, marketing or organizational methods.

Depending on the context, innovations have been classified differently. One of the more simple definitions includes Product, Process and Marketing innovations. While product innovation would entail changes or

additions to goods produced or services delivered; the process innovation deals largely with changes to the way goods are produced or services are delivered; and marketing innovations address the changes in the method or conditions for marketing the good, or changes in the placement or target of the good or service. However, when dealing with agriculture sector, a more comprehensive and frequently used classification includes institutional, technological or social innovations.

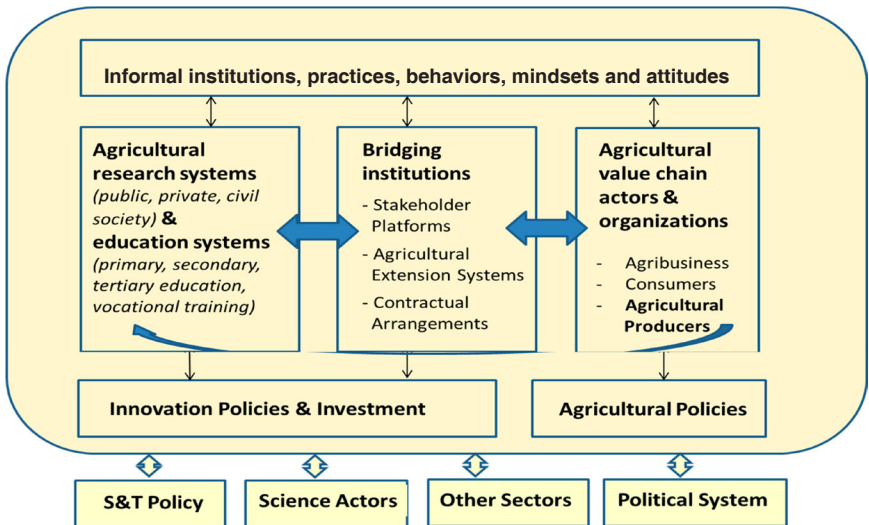
Institutional innovations encompass restructuring of organizations to bring about institutional changes in response to the exogenous factors to scale-up and generate richer innovations. These changes occurring in continuum, could be incremental, entailing modification of existing institution through change of institutional policies, processes, standards, practices, regulations, or more disruptive/radical, such as creation of new institutions altogether. Either way, the aim is to increase the flow of information within and across the organization and create an environment that is more conducive to enhanced learning, adaptability, and downstream product and process innovations. Institutional innovation is challenging and often met with friction, resistance, and contestation because of the dynamic tension between institutional persistence and innovative change.

Technological innovations are usually associated with product and process innovations involving knowledge creation and dissemination. In addition to application of new ideas, scientific knowhow to develop new products, they also entail improvement in technological practices that substantially increase production, production efficiency or result in improved services. Further, as technological product innovations often require development of new marketing methods, they may also be associated with marketing innovations.

Social innovations largely relate to new responses to pressing social demands. These may encompass new ideas (products, services, strategies and models), that bring positive changes in the way of meeting or responding to social needs and simultaneously create new social relationships or collaborations. Constructed jointly by several different stakeholders, they may generate employment, consumption, participation or introduce some other change to improve the quality of life for individuals and that can be replicated in other settings.

Process of Agricultural Innovation

Agricultural innovations do not occur in a vacuum, but in a particular socio-economic context and dynamic interaction among the multitude of actors. Focusing on research systems may increase the supply of new knowledge or technologies, but may not necessarily improve the capacity for innovation throughout the agricultural sector. Innovations emerge through collective action, linkages, sharing of knowledge and competencies among different stakeholders, who are all a part of the larger innovation system. Developing an innovation system necessitates creating much more interactive, dynamic, and flexible processes and requires enabling attitudes, practices, governance model to create facilitating conditions that make it possible for actors in the value chain to innovate.



A conceptual diagram of an agricultural innovation system (Source: *Sustainability* 2015, 7, 831-850)

Innovation networks are groups of agents (including farmers, private firms, researchers and farmer organizations), that voluntarily coordinate their actions and contribute knowledge and other resources to develop jointly or improve a social or economic process or product. Innovation capabilities depend both on individual traits (creativity, for example) and on collective factors, such as collective learning mechanisms and organizational cultures. They depend not only on innovative individuals but also on internal features of the organization, especially incentives, cultures, organizational spaces for experimentation,

coordinating structures and collective action. Innovation capabilities cannot be bought or built easily, and their development requires important investments and strong leadership over long periods.

Agriculture

The core objective of farming with a long tradition, incorporating practices, refinements, technologies, has been enhancing productivity and income per unit area and investments. Across the contour of Indian agriculture, spread in different ecosystems of Rainfed, Irrigated, Arid, Coastal and Hills, there are efforts at enhancing efficiency of operations and bringing new elements into farming systems on a regular basis. These could be in broad categories of soil and water management, crop improvement, crop production, crop diversification, crop protection, livestock and fisheries management, storage and marketing, use of ICTs for advisories from weather to markets. Over decades, this has been achieved through varietal improvement, increasing input use efficiencies, management of pests and diseases, integration of subsets of agriculture, diversification of produce, reducing harvest and post-harvest losses, value addition and so on. While there have been challenges all along, new ones such as climate change, emerging / transboundary diseases and market vagaries have thrown up new risks in agriculture.

Exploring the evolutionary process of innovations requires an initial phase to analyse the problem, with regard to its nature and intensity, existing approaches and solutions. Further, the conceptualisation of the idea / innovation, scientific rationale about the innovation, experimentation / trials conducted, technical support during the period, supporting data for the innovation, any resource mobilisation for the purpose, relative advantages of the innovation like adaptability, eco-friendliness, sustainability, gender equity and economic viability are assessed. Along with the originality of the innovation, both new or modified / refined, aspects of replication and promotion in terms of horizontal spread and adoption by farmers, socio-economic implications are also taken into account in order to recognise the innovation.

Innovations often cut across disciplines and commodities and hence synergise the problem solving approaches. With convergence of ideas and institutions as a prerequisite, resource and policy inputs are important for making innovations create impact. Suitable peer and governmental support would sustain and aid in disseminating the innovation to become a practice. It is in this context that several countries around the globe and

several states in India are setting Ministries and Departments for locating, recognising and mainstreaming innovations in different sectors of the economy and in farming too.

Application and utilisation of innovations are imperative for appreciation of the potentials for societal welfare. A conscious and constant effort in creating an ambience for innovations and upscaling and disseminating them to the users, as also recognise the innovators, is the way forward, where both governmental institutions and academies could play an important role. The Decade of Innovation (2010-20) is also an opportunity to realise the potentials of innovations in agriculture.

Agricultural Research Systems are mandated to provide technological solutions to problems based on science that are often universal. Nevertheless, there are site-specific issues like soil health, inter-commodity input and health management, damages and losses, customised mechanisation, storage and transport of agri-produce, value addition and so on, that require local solutions. This is where innovations of people at the grassroots have played a major role in 'making a difference' in terms of processes or products. There have been several such examples that have enhanced efficiencies of farming operations from 'seed to market', also found applications in other geographic areas or commodities.

Agricultural innovations are unique with regard to the processes as well as the players. Diversifying into new niches, integrating them into business models, also require capacities to handle new elements of farming and unfamiliar situations. With a large stakeholder component not common in other sectors, an environment for multilateral interactions on both supply and demand side needs to be established.

Frugal and Grassroots innovations

Innovation is a two-way street, between the scientists and the farmers. It is a fact that informal information sharing networks among farmers, the preservation of bio-diversity, seed exchange, pooling of human, animal and other resources and collaboration in sharing of water and other natural goods, are key strategies adopted by farmers in different parts of the country in the course of the pursuit of agriculture-based livelihoods. Capturing these strategies, practices and norms, is indeed an important goal for policy makers so that both the research agenda as well as agricultural programmes could be better designed.

The National Innovation Foundation (NIF) spearheaded the grass root innovation platform in the country. Honey Bee Network has been scouting, spawning and sustaining innovations by knowledge-rich, economically-poor people and a database of more than 140,000 ideas, innovations and traditional knowledge practices has been pooled. Specifically for agriculture, the ICAR-enabled Agripedia has provided for a repository and the National Agricultural Innovation Fund for facilitating the process of innovations.

The present day challenge is that the potential of research has to be realized by extending it in a manner that leads to new products, services and systems, that add value to bring about significant changes in income, employment and livelihood security of people; not only in rural India, but also to fuel the entire economy. In other words, bringing knowledge to create value has to be at the centre of the new approach. Conversion of first step recipes at the 'proof of concept' stage to innovations and making them fit for commercialization is the requirement. This necessitates catalytic support and facilities for demonstration of innovative product and processes so as to traverse the journey from 'laboratory' to 'pilot' stage and then commercial production.

In order to create entrepreneurs in large number and nurturing them through appropriate interventions / incentives / investments by generating new technologies, incubation has been conceived as an effective approach. This encourages growth of start-ups and innovative ventures by facilitating entrepreneurs' access to latest technologies, organising required services and resources to optimally work the technologies, and providing the required business development skills for commercial exploitation. The new generation incubators would foster partnerships between technology generators and industry through coordinated and focused approach to create commercial opportunities by capitalising on the synergies that would enable reducing not only the costs associated with research and development of innovative technologies but also the time to market. They would specifically address the constraints for mid-level validation, refinement and scaling up of technologies; and dealing with the issues of marketing and associated regulatory compliances.

Innovations to Business opportunities

Considering the unlimited potentials, more and more game-changing innovations are needed not only in developing and scaling up path breaking technologies, practices or products, but also in creating smarter business

practices / models. Packaging and delivering existing / new products and services to rural people across all income groups, and even export in the most cost-efficient manner are a part of this process. Numerous innovative and knowledgeable entrepreneurs should get involved to launch thousands of possible solutions, to address uncommon opportunities and complex challenges emerging every day.

Linked to this is the issue of creating successful agri-business models based on the research outputs. Skill upgradation in agri-business management and entrepreneurship development is considered a critical requirement to harness the fruits of efforts of public R and D institutions; and it is estimated that the returns to this investment will be at least 3-4 times initially and many times more eventually. The entrepreneurial and management skills are already high with the private sector, and a new breed of entrepreneurs is emerging even in rural settings.

These require mechanisms of collection and coordination in order to maximise the benefits of innovations, for a wider adoptability, further refinement, validation and incentivisation of such efforts. A value chain approach is essential to provide the required link and feedback from the 'market' for strategic planning to innovate new and appropriate technologies. Rightly, there is an evolution in the country with regard to transformation of agricultural R and D sector from primarily food self-sufficiency to market orientation. This requires partnerships with external agencies including seed producers, farm equipment manufacturers, grain wholesalers, agro-produce processors and so on, to realise the full potentials.

Further, in order to encourage, nurture and support technologists and scientists with initiative and potential to turn their innovative research ideas into sound commercial ventures, the mechanism of Business Planning and Development (BPD) Units has been initiated. This is acting as an effective platform for fostering the growth of sustainable business endeavours and provides a wide range of services such as research support; business planning; office space; access to information and communication technologies; and advice on management, marketing, technical, legal, and financial issues. The BPD Units have created Agribusiness Incubation Centre to support the development and scaling-up of growth-oriented, early-stage enterprises. They are meant to: i) provide the entrepreneurs with an enabling environment at the start-up stage of enterprise development; ii) help reduce the cost of launching the

enterprise; iii) increase the confidence and capacity of the entrepreneurs; and iv) link the entrepreneurs to the resources required to start and scale up a competitive enterprise.

Capitalizing on ICT developments

The role of information and communications technology (ICT) in producing and disseminating knowledge has expanded exponentially. ICTs offer striking opportunities for innovations by enabling a variety of stakeholders to interact and collaborate in new ways to enhance the innovation process.

With advancements in ICT, agriculture today operates within a dynamic ecosystem where production, trade and consumption behaviour are dominated by market forces and guided by the fast changing consumer preferences. While it is necessary to have a productive, competitive, diversified, and sustainable agricultural sector, it becomes all the more important to ensure that the smallholder farmers of the country are provided with gainful opportunities and avenues to access the benefits of such actions. With the increasing importance of marketing in Indian agriculture, enhancing the business skills of agricultural research institutions assumes great significance.

The potential of ICT to support the access to and exchange of information for smallholder farmers is clear. A rich discussion centred on examples of current pilots and processes is expected to bring beneficial results. It must be noted, however, that there continues to be a challenge in finding examples that have moved beyond the pilot stage, reaching scale in a sustainable manner.

Through improved communication, ICTs are known to enhance or expand human networks. Mobile technology is seen as having a particularly positive impact in this area, fostering networks of farmers and agribusiness, so that they can support each other. ICTs have allowed for innovations that bring financial services, including mobile money, to smallholder farmers. *Jan Dhan Yojana*, *Prime Minister Fasal Bima Yojana* in India, *AgriNet* Uganda, *M-PESA* in Kenya, and others, for example, have brought financial services to the previously unbanked, a critical component of improving smallholders' participation in the value chain. Other innovation models have used SMS, including systems such as *FrontlineSMS* and applications like *Twitter*, to reach a large number of individuals with advisory information in an efficient

and timely manner. While SMS-based systems seem to predominate at this time, technology and infrastructure will soon enable progress beyond short texts to allow use of more complex information, including images.

Community radio remains one of the most widespread and well studied ICTs, allowing farmers to access information and for service providers to provide information. Combinations such as radio and mobile phones can become an important tool in information exchange and community networking. Radio's positive role in reaching female farmers has been reaffirmed, along with a need for greater awareness of the gender inequity of different ICTs. A new experiment in Indian mass media is the DD-*Kisan* Channel, offering a huge scope for science-farming-trade linkage.

Farmers are the traditional innovators in agriculture, and actively engage in communication about innovation. Challenges that prevent the maximum benefit of ICT innovations being realized can be roughly grouped into three categories: technology, human capacity, and content. ICTs may make tools and information available, but farmers must know they exist and should be able to use them. The capacity of individuals to use what ICTs are available is often not assessed, leaving older people and women in some communities at a particular disadvantage. Hence, it is necessary to develop business development units / groups as models in potential research institutions for business planning and market development for commercialization of agro-technologies.

Farm Innovators

Agriculture is the largest private nano-enterprise in India, dominated by small farmers, who cultivate 44% of land, but contribute over 50% of total farm output. Considering all agricultural operational holders, cultivators, agricultural labourers, share-croppers, tenants, poultry and livestock rearers, fishers, beekeepers, gardeners, pastoralists, non-corporate planters and planting labourers, as well as persons engaged in farm-related occupations like sericulture, vermiculture, and agroforestry as farmers, the present need is integrated, remunerative, speciality and secondary agriculture.

We need to plan for a different world in 2030, as envisioned in Sustainable Development Goals and CoP21, for which a more productive, inclusive and sustainable agriculture, that strengthens rural livelihoods, ensures food and nutritional security, reduces demands on natural resources and

builds resilience to climate change, is a prerequisite. Farming today needs location-specific, time-bound solutions for the uncertainties prevailing from 'weather to markets', with knowledge, innovations and skills.

Appreciating that typical Indian farming is integrated and diversified, small farmer at the centre of farming must be recognised in a holistic manner, understanding the individual and the group, in the context of the 'monsoon-market-mindset' and 'more from less-for more' paradigms. The aspects that need to be considered for timeframes of 2030 and 2050 would be: (i) Demographic changes and food preferences (eg. starch to protein shift); (ii) Policy framework in the national economy; (iii) Land resources and soil health, including tenancy; (iv) Access to water and energy for agriculture; (v) Climate change including abiotic stress; (vi) Biodiversity; (vii) Disasters and risks; (viii) Convergence and integration of farming systems; (ix) Investments and capital formation; (x) Partnerships and gender equity; and (xi) Co-products (by-products from agriculture).

In the partnership approach, it is significant to note that a new breed of Farm innovators has come about in the country, adding to the list of Progressive farmers, Lead farmers and Expert farmers. Innovations in different areas of agriculture, when deliberated upon in a first meeting of its kind, revealed the insights that the farmers had, as well as the problem-solving approach each one brought to the practice, that we called 'FInnovations'. This brings out a new possibility of extension, emphasizing on the farmer-to-farmer technology transfer and learning across farms, commodities and systems. It is an opportune time to harness the potentials of the innovations, validate them on one hand, add value on the other, for fast tracking agricultural development in a comprehensive manner.

Literature

In preparing this Address, information has also been sourced from the official publications / reports of the IBRD / The World Bank; Inter-American Institute for Cooperation in Agriculture; Food and Agriculture Organisation (FAO) of the United Nations; Department of Science and Technology, Government of India; National Innovation Foundation; Indian Council of Agricultural Research and Institutes; CGIAR Institutions; and related papers available in the public domain.

