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Innovation-led Agricultural Growth: Challenges and Opportunities

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Need for Innovation

Accelerating agricultural growth is an important goal for most of the nations for achieving Sustainable Development Goals (SDGs), especially to remove poverty, have zero hunger and ensure environmental security. Those developing nations that have reoriented their agricultural research for development agenda towards scaling of innovations have made much faster progress. Greater the emphasis on agricultural research for innovation, higher had been the growth for agricultural gross domestic product (GDP) (Shenggen Fan, 2013).

In fact, Green Revolution was in itself an innovation led initiative around the use of high yielding dwarf wheat and rice varieties that responded favourably to higher inputs leading to quantum jump in productivity. The cradles of success had been: i) political support, ii) good institutions and human resource, iii) availability of critical inputs (seeds, water, fertilizer, etc.), iv) enlightened extension workers and hard working farmers, and above all, v) partnership among the stakeholders.

Considering emerging second generation challenges of Green Revolution like factor productivity decline, depleting natural resources, increasing cost of inputs, higher incidence of diseases and pests, higher cost of inputs, less profit to farmers and above all the adverse impact of climate change. Obviously, increasing income, especially of 80 % farmers who are small and marginal having holdings less than 2 ha would require technologies by which they can save cost on inputs and have more income by higher productivity and also by linking them to markets. Thus, scaling of innovations like hybrid technology, conservation agriculture, microirrigation, integrated nutrient management (INM), integrated pest management (IPM), adoption of genetically modified (GM) food crops, protected cultivation, etc, becomes high priority. For this to happen, enabling policy, strong public-private partnership and innovative extension systems to transfer right knowledge especially around

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secondary and spatiality agriculture would be needed. Moreover, innovation without incentives and rewards and congenial policy environment, including IPR regime, would not be possible for which we shall need innovative institutional as well as policy related initiatives to make a difference - as was experienced during the Green Revolution era.

For any innovation to be scaled-out, it is critical to assess their economic feasibility and potential for large scale adoption as well as impact. Moreover, many innovations are farmer led, which need to be assessed, validated, refined and outscaled in order to harness the expected benefits by farming community at large (TAAS, 2013). For this, farmer participatory approach need to be adopted with active involvement of scientists and provision of incentives, especially in the form of bankable projects with availability of credit at low interest rates of <4.0 % (Saxena, 2017).

Past Initiatives

Indian Council of Agricultural Research (ICAR), having the mandate for research, extension and education, had been engaged in providing national public goods that help accelerate agricultural growth by disseminating appropriate technologies to the farmers. In the process, Krishi Vigyan Kendras (KVKs), now numbering 680, have been instrumental in providing front line extension for scaling new technologies that had helped farmers increasing production as well as income.

Besides front line demonstrations (FLDs), a large number of farmers in each district have been provided access to new seeds, planting materials, good agronomic practices (GAP) and training of farmers for skill development. These institutional systems have helped considerably in making faster growth in different sectors of agriculture.

Provision of revolving fund for enhancing availability of seeds of improved varieties/hybrids, faster multiplication of planting material, fabrication of tools and implements, etc. all helped in accelerating the growth of Indian agriculture. Even to ensure effective involvement of private seed sector, the ICAR provided freely the breeder seeds of parental lines of hybrids of crop varieties for faster multiplication and distribution of seeds. This obviously led to faster growth of seed sector in India. Various mechanisms of incentives and rewards were also put in place in late 1990s based of Johl Committee Report (1995). Somehow, these incentives have not reached the real performers for their extra efforts due to bureaucratic hurdles and resistance to change. To encourage private sector involvement in research and development (R&D), even provisions of intellectual property rights (IPRs) and Protection of Plant Variety & Farmers Right Act (PPV&FRA) were enacted in the beginning of new millennium.

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Incentives and rewards were also an integral component of the prestigious World Bank Project named National Agricultural Technology Project (NATP), negotiated in 1998, followed by greater thrust of public-private partnership for scaling innovations under the second phase of WB project named as National Agriculture Innovation Project (NAIP). It eventually helped in outscaling many useful innovations for the benefit of end users - the farmers, producers and the consumers (ICAR, 2006; 2014).

Some of the recent initiatives for scaling innovations by the Ministry of Agriculture and Farmers' Welfare are: Attracting Rural Youth in Agriculture (ARYA), Mera Gaon Mera Gaurav, National Skill Qualification Framework, skill training, Value Addition and Technology Incubation Centres in Agriculture (VATICA)', knowledge systems and homestead agricultural management in tribal areas, nutri- sensitive agricultural resources and innovations (NARI), climate smart villages, web and mobile advisory services. The potential role of farmer producer organizations (FPOs) in innovation upscaling is also important.

The Department of Biotechnology (DBT) has also taken up several initiatives for scaling innovations through Biotechnology Industry Research Assistance Council (BIRAC), a platform to nurture industry-academia connectivity. Other initiatives include biotechnology parks and bioincubators, science clusters, etc. Even though there are different schemes for agricultural biotechnology such as Biotech-KISAN scheme, the performance is not on par with other sectors like health. There are also schemes to encourage scientist/faculty to move to entrepreneurship. The key challenges for the entrepreneurs are lack of financing and market access. DBT had started several initiatives such as Students Innovations for Advancement of Research Explorations (SITARE), eYUVA (creating entrepreneurial culture in universities), BioNEST (nurturing entrepreneurship by establishing Bioincubation Centres) for supporting entrepreneurs. Also, there is a need for accelerating entrepreneurship fund and possibility of social immersion programmes for incubates to assess the market needs (Renu Swarup, 2017).

Similarly, various initiatives by the National Innovation Foundation (NIF) for promoting grassroot entrepreneurship included Micro Venture Innovation Fund, Grassroot Technological Innovation Acquisition Fund and establishment of NIF Incubation and Entrepreneurship Council. Innovations are also encouraged by organizing exhibitions and through awards and scholarships. Participatory research and decentralized fabrication and services are essential for improving technologies for outscaling in India (Usha Zehr, 2017).

Innovations need to be considered in totality; Invention, Innovations-Policy-Institutions being so essential to develop a strategy for their scaling-out.

ICAR needs to strengthen the existing policies, institutions and incentives for upscaling and outscaling innovations. The existing policies and mechanisms need thorough review in the present context. There is an obvious need to have competent human resource with marketing expertise so as to commercialize the technologies and taking them to small farmers BIRAC model of DBT is a platform for innovations, similar model needs to be developed in ICAR Farm Producer Organization (FPO) could be a good option for promoting agricultural innovations and commercialization of technologies. While planning for upscaling and outscaling, adequate care needs to be taken to avoid planning fallacy (underestimation of the time and resources). Now we need to think "can innovation be really engineered?" and applied to address the present day requirements of smallholder farmers (Gulati *et al*., 2006; Renu Swarup, 2017; Suresh Pal *et al*., 2017).

As stated earlier agriculture being an important sector for elimination of poverty and hunger, and addressing the concern of climate change, key Sustainable Development Goals (SDGs), importance of relevant innovations can't be overemphasized for inclusive agricultural and economic growth (Shenggen Fan, 2013). In order to create needed environment for innovation, emphasis on capacity development is essential for India to progress and compete, especially in the era of globalization. Hence, generating new innovations to meet emerging challenges, involving both public and private sectors is the need of the hour. The impact of innovations would be possible only through the implementation of commensurate policies and required IPR regime. In this context, "National Intellectual Property Rights (IPR) Policy" and implementation of Protection of Plant Variety and Farmers' Right Act (PPV&FRA), by the Government of India would certainly accelerate the pace of innovations (Saxena, 2017).

Relevant Experiences Abroad

Since industrialization, agricultural innovations in the developing countries had predominantly been brought in by the public sector. But with commercialization of agriculture, private sector including multi-national companies (MNCs) having base in developed countries have been major providers of technology. In the United States, public sector universities became R&D labs for the private companies after the enactment of Bayh-Dole Act of 1980 (Bayh-Dole Act, 1980), which allowed universities and other non-profit institutions to have ownership rights on their discoveries that resulted from federally-funded research. This facilitated transfer of technologies to the private sector through establishment of Science Parks and Incubators. Europe also followed similar institutional framework to facilitate new innovations and their faster dissemination. Lately, greater emphasis on innovation

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in China, mainly public funded, has transformed its economy through greater participation of private sector and foreign companies for out scaling innovations.

In the pre-World Trade Organization (WTO) era, as stated above, the public sector institutions in the developing countries had played major role for generation of national public goods through agricultural research. On the contrary, in the past-WTO era, with economic liberalization, the private sector investments in agricultural innovations helped in faster delivery and adoption. Some of the developing countries moved faster in promoting the culture of corporation in research and development (R&D). MLSCF (Malaysia), Fundacion (Chile), CENTEV (Brazil), Technoserve (Mozambique), Timbali (South Africa) and IAA-IPB (Indonesia) are such public sector funded research institutional incubators that have worked in partnership with private sector for upscaling and outscaling innovations. Also, some multi-stakeholders platforms did get developed for scaling innovations (e.g. MasAgro, Mexico) (Shenggen Fan. 2013).

Current Challenges

Earlier, agri-innovations had relatively simple process/cycle of their development and dissemination through public extension system for the benefit of end users, mainly the farmers. However, with the emerging complexities of modern time, new and rather more efficient players have entered in the process. The emphasis on commercialization of technologies and resource generation has also necessitated involvement of new actors, mainly private sector companies in commercialization of research products. These new initiatives are mainly being guided by profit motive and finding favour because of efficient and faster delivery mechanisms, though sometime more costly for smallholder farmers. On the other hand, some rural innovations by enterprising farmers are also recognized as potential options for solving the location- specific problems, but they need validation, further refinement and outscaling for the benefit of larger farming communities,. Mainstreaming of such innovations is, therefore, a challenge which needs to be recognized and resolved by appropriate incentive and reward mechanisms and institutional/public-private partnerships. Thus, innovations have moved away from the conventional innovation systems (linear transfer of technology) to those of agricultural innovation systems (multi-stakeholder platforms) and also to farmers' innovation systems - grass root innovations (Saxena, 2017).

There is a need for figuring out complementarity between the public and private research organizations for scaling-out agricultural innovations for small holder farmers and major barriers in such collaborations. Unlike the public sector, private sector concentrates on fewer technologies and invests heavily on those technologies.

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The key constraint with private sector in R & D is longer duration (7-10 years for varietal development) and continued investment during that period. The major preconditions for scaling-out innovations are that the threshold be need based, relevant, and should have the proof of concept, regulations, cost of compliance, incentives and a sense of urgency (Bhooshan, 2017).

Somehow, the innovations have not been subjected to evaluation for socioeconomic impact as being done in the developed world. Taking clue from the technologically advanced economies, India also realized that adequate efforts have not been made to encourage and emphasize on promoting innovations which is a key factor to generate agribusiness opportunities and to increase farmers' income. Also, guidelines for incentives and rewards for outscaling innovations and resource generation were not effectively adopted. Somehow, the pace of promoting innovations and allowing the right incentives to researchers have also remained slow (Saxena, 2017)

Problems such as nutritional security, climatic change and declining profitability are some of the major issues and challenges which need urgent redressal. In-depth analysis of commercialization mechanisms at the system and organization levels has not been paid due attention which needs to be done on priority for upscaling and outscaling agricultural innovations. Also, the lack of enabling policies, slow dissemination of technologies, intellectual property right issues, inadequate infrastructure for capacity development, and lack of financial resources also pose serious challenges in faster adoption of innovations and these need to be effectively addressed.

Opportunities for Outscaling Innovations

There are several technologies which need to be outscaled. In the dairy sector, such technologies include animal identification, precision animal feeding, advanced reproductive technologies, disease diagnosis innovations, technologies for detection of adulterants in milk and milk products, small-scale farm machineries (such as mobile machine milker). There are now four generations of technology for improving reproductive health and these must be scaled out. Artificial insemination and semen sexing can make a major impact on milk productivity. Kerala and Kolar Model of community milking, and technology for value added dairy foods are now standardized and need immediate interventions for their outscaling. In order to better understand technology and their spread, people's mind-set of "managing livestock under zero or low input" should be changed to "commercial enterprise" (Indra Mani, 2017).

Scaling-out innovations in case of agroprocessing and value addition also needs to given due attention. Exploitation of value added products from agrobiomass

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like lignin and algae, food products of bioprocessing and chemical processing and composite fruit coating can generate immense benefits for farmers and rural entrepreneurs. Most of these processes are restricted to labs and require scaling-up. There is a need of Government support for upscaling innovation in this sector through R & D and establishment of incubation centres. Such support needs to be proactive and facilitate integration with industries (Bhooshan, 2017).

There is a need for upscaling and outscaling for small farm mechanization technologies in India. Greater attention needs to be paid on involvement of industries for commercialization. Contract research on Urea Ammonium Nitrate Application System funded by the Dept. of Fertilizers and National Fertilizer Ltd. is a good example of success. Unique facilities such as 'Design Innovation Centre', a collaborative initiative by Indian Institute of Technology (IIT), Kanpur and Indian Agricultural Research Institute (IARI) is a promising model for incubation, design improvements and start-up facilitation. There is also a need for more public funding for research in agricultural mechanization, establishment of national centres in different zones for mechanization, scaling-up innovations through public-private partnership (PPP), linking of grass root level innovations through institutional innovations and establishment of design innovation centres at different institutions (Jat, 2017).

Innovations in protected cultivation for producing high quality, high value agricultural produce are very important These include plastic mulching coupled with fertigation, walk- in poly- tunnels for vegetables, insect proof net house, shade net structures, vegetable farming under rain-shelters, naturally ventilated poly house, climate controlled hi-tech green houses for disease free nursery raising, hi-tech soil less production etc. Protected vegetable cultivation had been very successful in Ladakh and several other places. However, there a few key constraints which include high initial cost, poor quality material, high cost of inputs, lack of guidance, knowledge and marketing, nematode problem, lack of refrigerated vehicles. In order to outscale such technologies, there is a need for further R & D efforts in developing crop varieties/hybrids suitable for protected cultivation, skilled human resources development, establishment of Bureau of Indian Standards (BIS) standards for polyhouse materials and its testing facility, cluster approach and streamlining of subsidy. Low cost polyhouse, mulching, fertigation have proved to be more popular because of their low cost (Singh, 2017).

There are various options for outscaling innovations in natural resource management. Innovation is an amalgamation of technology, local adaptation,

social inclusivity, and access of end users. It is important to understand the big challenges associated with "half innovations" and the successful cases of converting half innovations into full innovations based on local needs. Major requisitions for outscaling NRM innovations includes long-term investment, system approach, portfolio of policies and practices, patience, capacity, innovation led business models and robust ex ante analysis on return on investment. The scientific social responsibility/ science-corporate social responsibility needs to be given due importance. Since these NRM based innovations generate lot of social and environmental goods, there is an urgent need for greater public investment in their promotion and use (Jat, 2017).

The various technologies outscaled by public institutions, such as Indian Agricultural Research Institute (IARI) and strategies adopted for outscaling innovations include technology commercialization through PPP, assuring access to knowledge and information through PUSA KRISHI-app, partnerships for enhancing service provision and linking farmers with market through FPO (Beej India Ltd.). The issues, concerns and challenges include disconnect between production and marketing, licensing issues with industries, lack of exclusive funding support to agro start-ups, insufficient delegation of powers to cutting edge level institutions, lack of strong actions against IP violation, lack of trained professionals and technology readiness. The way forward could be demand driven R &D, with more industry/research/academia interaction, technology transfer and integration with incubation for start-up, virtual marketing place and use of mobile/internet technologies.

Greater emphasis is required for providing incentives to the researchers ICAR has taken steps to grant incentives for patenting, innovations and partnership and to establish IP management structure involving institute and zonal technology management units and national platform - Agrinnovate India Ltd - for interface with private sector, including international technology transfer. Emphasis had also laid on the role of vision, skill, incentives, resources and action plan for innovation. There is a need for establishing central cell/platform to screen the innovations at ICAR level. There is also a need for creating innovation fund to promote and commercialize new technologies. The research efforts needs to be taken-up in a systems' approach rather than the trend based on disciplines / commodities.

There are some major innovations that currently need to be out scaled as a matter of priority keeping in view their expected impact and the benefits being national public goods. These are: i) hybrid rice - the current area coverage in last two decades is hardly 2.0 m ha, whereas scope exists for at least 10.0 m ha in the

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next decade; ii) single cross maize hybrids - the area covered under these hybrids presently is less than 60 %, whereas scope exists for almost 90 % of maize area; iii) conservation agriculture - under rice-wheat cropping system, current area is about 3.5 m ha, whereas scope exists for almost 8.0 m ha in the Indo-Gengetic Plains alone. The CA innovation also has vast scope under rainfed farming covering around 55 % of the total 144.0 m ha cultivable area in the country; iv) protected cultivation - the current area under protected cultivation is 40,000 ha, compared to 2.0 m ha in China; v) microirrigation - out of total irrigated area of 64.7 m ha, the area so far covered under microirrigation is only 7.7 m ha, which can certainly be doubled in next decade. Hence, it is evident that to harness the benefits of these innovations, concerted efforts are urgently needed in a Mission Mode. There are many more useful innovations that need to be out scale immediately and hence require a critical introspection as to how these can be scaled much faster for the impact on livelihood of small holder farmers (Jat, 2017; Singh, 2017).

Policies for Innovations

For successful scaling of innovations, there is an urgent need to put in place enabling policies such as: i) institutional policies such as facilitation of farmers collectives like FPOs with proper legal framework , establishment of cadre of agri-business professionals at village level, credit to the farmers across value chain, machine rental services, etc., ii) research policies aiming at promotion of agroecological based research, research for trade policy, agroprocessing, value chain development, sustainable livelihood, new funding models for encouraging research by state government , iii) price policies around fixing of minimum support price (MSP), inclusion of efficiency, compensation for risk and eco system services, and iv) investment policies for more investment in agriculture rather than subsidies, and promoting private investments. There is also an urgent need to attract private sector in development of whole sale markets, warehouses and cold storages, agroprocessing infrastructure, canal irrigation and agricultural extension. The National Agricultural Research System (NARS) had undergone various policy reforms in research, intellectual property rights (IPRs) and technology transfer (Saxena, 2017; Suresh Pal *et al*., 2017).

Also, there is an urgent need for human capital for development of innovation and invent-innovate-invest continuum and concepts of skill, speed and scale in innovation system. The country needs to place greater emphasis on human capital development, particularly for building entrepreneurship for which availability of adequate funds is essential. There are concerns over the abysmal state of credit and information access by the farmers in India, through it had a huge impact on

the income. Such concerns relate to livestock sector insurance (presently granted only for a year and that too for high yielding animals) and issues around taxation of dairy, fishery and poultry enterprises. There is an urgent need to develop value chain approach both in research and in policy.

Even though technological innovations are abundant, institutional failures lead to lower adoption. The problem of lack of appropriate policies, institutions and technologies were also present at the cusp of the Green Revolution during 1960s. Whereas Government has an important role to play even now, the innovation system has become multi-sectoral involving other actors. Therefore, there is an urgent need for institutional and policy reforms which are more appropriate in today's context. Institution or policy failures need to be revisited and more suitable policies and institutions developed. The lack of internal capacity for negotiating complex trade and other international treaties need to be addressed, on a priority basis. The United States of America has a much stronger private sector activity in venture capital, whereas European countries have a number of public sector business models for scaling-up and scaling out innovations in agriculture. Who bears the risk in innovations which are fostered and how risks and rewards are shared between the public and the private sector are issues which need clear business models? Government should also innovate shifting from being mainly directive to a more facilitative role in promotion of innovations. This would require a cost-effective regulation system for investment and commercialization of economic, efficient and productive innovations (Gulati *et al.,* 2006; Shenggen Fan, 2013).

The major policies for scaling-up innovations should center around incentive (non-subsidy) and reward system, enabling policy environment for faster adoption of innovations, increased resource allocation for agricultural research for development (at least 1% of agricultural GDP), scaling innovations through public-private partnership, and policy and institutional reforms for large scale adoption of efficient resource saving technologies such as conservation agriculture (CA).

Different states led institutional and policy reforms for outscaling innovations in microirrigation and water management are worth critical assessment for this impact. The states of Rajasthan, Andhra Pradesh, Maharashtra and Gujarat cover about 45 % area under microirrigation, whereas potential for this technology is estimated to be 8.6 m ha in the country. Andhra Pradesh model of Micro- Irrigation Project, Karnataka PPP model and Rajasthan model of allowing only microirrigation and ban on floor irrigation in canal area are some of the successful examples replicating in other states.

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Intensifying Agri-Innovations

The evolution of Indian National Agricultural Research and Extension System (NARES) has primarily been based on social commitment and with a motive to provide national public goods and to serve large number of resource poor and small farmers. Thus, innovations had been an integral part of Indian AR4D system right from the beginning. In view of the need for evaluation of innovations for socioeconomical impact, India also realized the need for encouraging and emphasizing on innovations to generate agribusiness opportunities and to increase farmers' income. It is in this context, ICAR timely responded and prepared guidelines for Agri-IPRs Management and Commercialization in 2006 (Johl Committee Report, 1995; ICAR, 2006) and also initiated a National Agriculture Innovation Project (NAIP) with funding from the World Bank. Also, guidelines for incentives and rewards for outscaling innovations and resource generation were put in place. Somehow, the pace of promoting innovations and allowing the right incentives to researchers has remained slow (Saxena, 2017).

A countrywide network of Institute Technology Management Units (ITMUs) have been created for management of agri-innovations and agri-intellectual properties in all ICAR institutes duly supported by the Zonal Technology Management & Business Planning and Development (ZTM & BPD) units at selected five ICAR institutes. This new initiative did help in kick-start innovation awareness and importance of their commercialization. ICAR Rules and Guidelines for Professional Service Functions were accordingly published for smooth implementation of Indian Agri-IPR Network in the year 2014 (ICAR. 2014. Eventually, many agri-technologies and services from Indian NARES have successfully been commercialized. The Business Planning and Development Unit (BPD), under National Agricultural Innovation Project (NAIP) project, and Agri-Business Incubators (ABIs) established under National Agriculture Innovation Fund (NAIF), was an experiment aiming at commercialization of new innovations. Accordingly, the entire process of innovation generation and commercialization, involving public-private partnership, led to an intangible treasure of experience, which needs to be intensified for better management of agri-innovations in future (Bhooshan, 2017).

The strength of an innovation is generally considered in terms of its commercial and societal value. As such, a large number of agricultural innovations identified and commercialized during the previous decade need to be outscaled. Also, India needs to innovate further in order to address the emerging challenges in agriculture.. Role of private sector, though well realized and appreciated for input development and delivery, is still to be appreciated and expanded to non-conventional areas and

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the role and importance of public- private partnership has to be appreciated and promoted further. In addition, there should be adequate provision of dissemination of innovations for management of natural resources and sustainable farm practices, which are significant for agriculture but possibly may not invite attention of private sector (Gulati *et al*., 2006; Usha Zehr, 2017).

In a short span of agri-innovations and IPRs regime, India has successfully commercialized some new technologies. In addition, ICAR has built the needed capability of handling innovation and IPR related issues in future. However, there are many innovations and technologes which remain underutilized. Important among these are animal health, protected cultivation, microirrigation, watershed development, hybrid rice, GM seeds, bioagents, farm machinery, post-harvest technology, etc. Hence, there is an urgent need to revisit technology dissemination and commercialization mechanisms and associated policies in the context of scaling current and future technologies.. There is also a need for looking at the commercial aspects as well as the incentive and reward system for the innovators, so that a clear road map is put in place by having an enabling environment, appropriate policies and necessary incentives (Saxena, 2017).

The Way Forward

The following are the important major action points for developing strategies for scaling innovations for impact on smallholder farmers:

- Innovations have played and will continue to play a significant role in agricultural transformation globally. The innovation process involves multiple stakeholders and right policy environment to scale-out for impact in the broader national agricultural perspective.
- Agricultural research must move from commodity centric to systems' approach, and all stakeholders (farmers, private sector, NGOs, etc.) be part of the research and innovation continuum. Hence, institutional/ innovation platforms are essentially needed to encourage much needed scientist-farmer, and public-private partnerships.
- In order to achieve an innovation driven agrarian economy, innovation capacity of research and development systems, civil society organizations (CSOs), and especially the farmers should be developed. For this purpose, intensity of public investment will have to be enhanced considerably. Also, greater attention would be needed towards capacity development of people responsible for scaling innovations for successful commercialization.

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- There is an urgent need to strengthen existing technology transfer system within NARS (frontline extension, Agri-Business Incubator, Agrinnovate India Ltd.) and establish technology parks as well as transfer systems for commercialization both in ICAR and SAUs. Also, it requires placement of adequate manpower, financial resources and freedom to operate. Convergence of technology and diversification of extension and other service systems are also critical for outscaling innovations.
- The available innovations, including those that are farmer-led, must be assessed for needed validation, refinement and prioritization based on their commercialization potential. This should also entail identification of suitable partners for the successful ventures. Financing, risk management and incentives for outscaling innovation are necessary to encourage potential entrepreneurs.
- An Innovation Platform would help accelerate scaling -out innovations and, therefore, an 'Agri-Innovation Board' is required to be established urgently in the Ministry of Agriculture and Farmers Welfare. This Board must be headed by an eminent agricultural scientist and its members be drawn from different Ministries, including Finance, Commerce and Industry.
- To begin with, the Board should have a minimum of INR 1,000 crores for financing the activities to scale -out agricultural innovations. This could be from existing funding support for innovation (Start-up India, Atal Innovation Scheme), or a separate funding mechanism such as National Innovation Fund (NIF) initiated by the Council of Scientific and Industrial Research (CSIR).
- Concerned ICAR institutes and SAUs must ensure providing skill based certificate training for entrepreneurship, and in addition to provide much needed backstopping services so critical for successful scaling of innovations. The manpower, so trained, can work as para-innovators or technical service providers. Also to link with the industry, ICAR would need to develop effective partnership with organizations such as Federation of Indian Chambers of Commerce and Industry (FICCI), the Associated Chambers of Commerce and Industry of India (ASSOCHAM), Confederation of Indian Industry (CII), etc.
- Farmer Producer Organizations (FPOs), self-help groups, cooperatives, producer companies, etc., could effectively be involved for outscaling innovations. These organizations should have easy access to technology,

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financial services, including credit, and hand-holding from public organizations for promoting demand-driven innovations in the broader national interest.

- Participation of private sector in R&D and upscaling and outscaling of innovations needs an enabling policy environment and access to public technology and other resources. In order to facilitate this, the Government should move from "directive" to a "facilitation" role. This may also require revisiting of existing regulations in order to provide a "predictable and enabling" regulatory framework. Also, incentives and rewards to innovators need to be put in place to sustain their interest in outscaling and much needed technical backstopping.

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