



Farmer led innovations: Retrospect and prospects

HEMA BALIWADA¹, J P SHARMA² and RESHMA GILLS³

ICAR–Indian Agricultural Research Institute, New Delhi 110 012

Received: 25 February 2016; Accepted: 4 July 2016

ABSTRACT

Agricultural development in any country is innovation driven. At the end of the development process, innovation makes the difference in farmers' adoption decision. Indian farmers have also been in the process of continuously improving available technologies and innovating new ideas for more efficient and cost-effective farming, which has resulted in numerous innovations over the generations. It helped not only to improve farming practices but also to ensure better livelihood options. Despite its relevance and importance, it has neither been documented nor recognized. Even if the documentation has been done, the Intellectual Property Rights on the innovations made by the farmers has often been ignored. The innovations have neither been properly institutionalized for their horizontal and vertical expansion nor properly disseminated. Though, initiatives by government and non-government bodies to identify and document the farmer led innovations have taken place in recent past but in a limited scale only. It is therefore necessary to provide sufficient and suitable institutional support to the farmers for the promotion of farmer led innovations and to document, validate and scale up of these innovations. The institutional arrangements for networking of stakeholders need to be devised to translate the challenges faced in the institutionalization of farmer led innovations into opportunities. The present article is an attempt to document the importance of farmer led innovations, role of institutions in promoting it, reasons for slow pace of spread and strategies for scaling up the farmer led innovations with special emphasis on Indian conditions.

Key words: Documentation, Farmer led innovations, Institutional support, Scaling up

Agriculture contributes to 40% of the global workforce. For a large number of developing countries, it is the critical sector as it employs 55% of labour force (UN 2007, FAO 2007) for feeding the population, provides subsistence, income, etc and India is not an exception to this. Agriculture continues to be the backbone of Indian economy employing 54.6% of the total workforce (PIB 2015) and with the total share of 13.9% on Gross Domestic Product (Central Statistics Office report 2015). India, with total food grain production of 257.07 million tonnes (Economic survey 2014-15) has to feed 1.2 billion population (Census 2011, Business standard 2014). In 2015, India had 1.31 billion people, according to the United Nations revised new estimates, against China's 1.38 billion, a difference of 65 million people (UN 2015, Economic Times 2016). By 2020, India's population is likely to be around 1.4 billion (UN 2015). With opportunities for area expansion being almost exhausted, additional food output of 4-5 million tonnes per annum is required (ICAR Vision 2020).

Farmer led innovation refers to the dynamics of indigenous knowledge (World Bank 2004, Mariam *et al.* 2011, Soedjana *et al.* 2015), consists of processes of

developing new technologies or modification, adaptation, and experimentation of own or external ideas, practices, techniques or products by individuals or group of farmers without direct support from external agents or independently of formal research (Wettasinha *et al.* 2008, Sule akkoyunlu 2013) and farm innovators are those who often undertake innovative efforts to solve localized problems, and generally work outside the realm of formal organizations (Olga 2015, European Union report 2011). The results of farmers' innovation processes are inexpensive, easily accessible, locally appropriate and already tested in real farm practice. They are therefore more rapidly accepted by other farmers than are the results of formal research (Prolinnova 2009).

An overview of conducive environment of innovation development among farmers

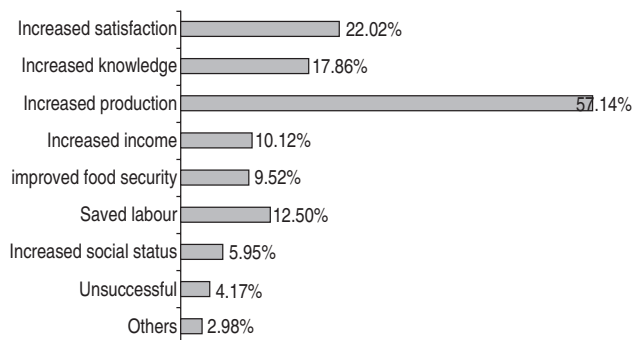
The innovations range from experimenting with new ideas, modifying or adding value to existing or external practices to complete discovery of better farming practices (Leitgeb *et al.* 2013, Tambo 2014). Interplay of ideas from multiple sources could lead to the emergence of farmer led innovations (Wolf 2008, Kummer 2011, Wunscher 2014). The sources of innovative ideas come from exogenous (formal) innovations mostly evolved from research institutes and extension based organisations and the endogenous (informal) innovations were mainly discovered through

¹Ph D Scholar (e mail: hema.baliwada@gmail.com), ³Scientist (e mail: reshma1818@gmail.com), Division of Agricultural Extension, ²Joint Director (Extension) (e mail: jd_extn@iari.res.in).

grandparents, fellow farmers, lead farmers, self-initiation and trial and error (Wolf 2008, Abdullahi *et al.* 2014). Grassroots innovations emerge when existing systems and practices fail to serve people's needs (AnnWaters-Bayer *et al.* 2015). They can arise through serendipity, systematic experimentation, trial and error, or combining solutions in new ways. Innovations can also emerge when an idea in one field is applied in a totally different field, called as analogue innovation (Gupta 2013). According to Bayer (2013) the main motivating factor for developing innovation is curiosity followed by increased production.

Relevance of farmer led innovations

Farmers innovate to improve their performance, through reducing their costs or increasing the demand for their product (OECD/Eurostat 2005). The value of grassroots innovation and traditional knowledge, which is largely held by marginalized communities, has also been widely recognized by the practitioners, including the Honey Bee Network. Local innovations sometimes emerge that are able to solve challenges that are highly location specific. Some of these are based on traditional knowledge while others are based on new ideas or thoughts (Brigidletty *et al.* 2012). The local innovations are technical, socio-institutional and change of practices at local level (Fetien *et al.* 2009). Many of the previous studies and evidences showed that impact and differential effect of different farmer led innovations varied with region, community and country. Farmer led innovations in developing countries would lead to increase in production, thereby reducing poverty among the rural people (Spielman 2009, Mariam *et al.* 2011). Most of the innovations are labour saving, thus, reduction in production costs and freeing labour for off-farm employment (Wunscher 2014). It is argued that innovation generation practices of farm households may also be making impacts in poor people's livelihoods and might form the basis for food security (Letty *et al.* 2011). Innovations can also be distinguished by their impacts on economics and markets which affect their modeling; these categories include increased yield, shelf-life and quality, reduced cost and risk, and increased environmental-protection (Sunding *et al.* 2000). The impacts are often combinations of technical, social and institutional changes (World Bank 2006). Another dimension used for measuring the impact of farm innovations on livelihoods and wellbeing were returns versus expenditure on stimulating/supporting informal innovation and number of joint experimentation processes supported (Brigidletty *et al.* 2012). Impact of innovation is assessed based on rural people's ability to better utilize the natural resource base and thus enhance their production, increase food security and nutrition and diversify their livelihoods and preserve the ecosystem (UN 2008, Morris *et al.* 2007 and Gildemacher *et al.* 2009). According to Tambo (2014) (Fig. 1) increased production is the major outcome of most of the farmers' innovations followed by increased satisfaction and knowledge. Another important area of impact of farmer led innovations is farmers' capacity to continue the process of



(Source: Tambo 2014)

Fig 1 Impact of farmer led innovations

innovation to address other challenges through strengthening individual capacities, such as confidence, knowledge and to handle experimentation and innovation (Wettasinha *et al.* 2014).

Role of institutions in promoting farm innovations

Institutionalization is the need of the hour for horizontal and vertical scaling up of farmer led innovations. 'Scaling-up' is the process of reaching larger numbers of a target audience in a broader geographic area by institutionalizing. It benefits the nation in general and farmer, his society in particular. Keeping this in view, many government and non-government organizations are working for scaling up of farmer led innovations either directly or indirectly. It is important to understand the institutional setup that enables these farmer led innovations to materialize (Sunding *et al.* 2000). At global level, PROLINNOVA (Promoting Local Innovation in ecologically-oriented agriculture and natural resource management), an NGO initiated international network for promoting local innovation involving partners from national NGOs and government institutions working on flexible funding mechanisms for farm innovators. They developed the concept of locally controlled 'Innovation Support Funds' (ISFs) that would allow farmers to invest in their own research, to hire external resource persons to support it, to access external information, and to conduct cross visits (World Bank 2005). In addition, many donors, policy makers, Civil Society Organizations (CSOs), government organizations, NGOs, farmer organizations are now seeking ways in promoting local innovations. While there has not been research in this area, it seems that the easy availability of numerous sources of funding to finance new ventures (e.g. venture capital) enables the entities that own the rights to new innovations to change the way out (Sunding *et al.* 2000). In India, many institutions/organizations like Indian Council of Agricultural Research (ICAR), National Innovation Foundation (NIF), PPV&FRA (Protection of Plant Varieties and Farmers Rights Authority), NABARD, etc are vigorously working for documentation, validation, commercialization and scaling up of farmer led innovations. The activities are briefly mentioned below.

Indian Council of Agricultural Research, the apex body

for research, extension and education has started many initiatives for recognition, up scaling and commercialization of the farmer led innovations. Intellectual Property and Technology Management cell (IP&TM) of ICAR oversees all matters related to intellectual properties and technology transfer/commercialization of new ideas. It is maintaining data base of successful innovative farmers for better dissemination. In order to recognize the outstanding contributions of innovative farmers in innovation adoption, modification and dissemination of improved technology and practices for increased income with sustainability, ICAR gives Jagjivan Ram Innovative Farmer Award; N G Ranga Farmer Award and NASI (National Academy of Sciences India-ICAR Award. ICARs Zonal Technology Management and Business Planning and Development units (ZTM and BPD) main objective is to protect Intellectual Property Rights, showcasing, transferring and commercializing the ICAR institutes innovations. They also act as Agri Business incubator to Incubate new start up businesses. The five Zonal ZTM and BPD Units under ICAR were developed to facilitate business and strengthen public-private partnerships. These zonal units also project the ICAR technology profiles available at various ICAR institutes located in the respective zones. The ICAR established ATARIs (Agricultural Technology Application Research Institute) to coordinate with SAUs, ICAR institutes/organizations, line departments and voluntary organizations in the zone for implementation of KVK mandated activities; and facilitating financial and infrastructural support to KVKs for effective functioning. Besides this, IARI (Indian Agricultural Research Institute), the premier institute, started fellow farmer scheme, inviting Innovative farmers to the institute to share their experiences, documenting success stories of innovative farmers and to recognize and awarding the innovative farmers in its annual krishi vigyan melas. Almost all the State Agricultural Universities, state departments, KVKs, ATMAs are documenting the farmer led innovations at district level and recognizing them through kisan melas, exhibitions, seminars, conferences, etc. (ICAR report 2015).

NIF (National Innovation Foundation), a voluntary organization has made many attempts to protect the farmer innovations, recognizing with awards in various platforms and scaling up. Building upon the Honey Bee Network philosophy, NIF was set up in 2000 to provide institutional support for scouting, spawning, sustaining and scaling up the grassroots innovations across the country. It is autonomous body of Department of Science and Technology. Its primary aim is to recognize, respect and reward grassroots technological innovators and traditional knowledge experts. It endeavors to build a National Register of green Grassroots Technological Innovations and Traditional Knowledge practices. NIF covers the entire gamut of the activities from scouting and documentation of green grassroots innovations and traditional knowledge, to value addition, intellectual property protection, business development, commercialization and social diffusion. It has been able to build up a database of more than 211 600 technological

Table 1 Scouted and patented grassroots innovations of NIF

Year	Scouted GRI	Patents filed
2001	1643	2
2002	19461	13
2003	25809	38
2004	16455	16
2005	31744	5
2006		31
2007		51
2008	24442	41
2009	35000	20
2010	4156	45
2011	7636	210
2012		85

Source: Olga 2015

ideas, innovations and traditional knowledge practices from over 575 districts of the country. NIF has till date recognized more than 775 grassroots innovators and school students at the national level in its various award functions. Pro-bono arrangement with patent firms has helped NIF to file over 743 patents on behalf of the innovators and outstanding traditional knowledge holders of which 37 patents have been granted in India and 5 in the USA. Besides this every year NIF organizes National Exhibition of Innovations at Rashtrapati Bhavan estate, New Delhi to exhibit the innovations and recognizing with awards (NIF Report 2015)

Protection of Plant Varieties and Farmers Rights Authority (PPV and FRA) set up in 2005, to provide an effective system for protecting the rights of farmers and breeders in conserving, improving and making available plant genetic resources for the development of new varieties of plants. It provides rights to farmers to register their seed varieties following DUS (distinctiveness, uniformity and stability) test criteria and share in the benefit derived from their commercialization. Such protection is likely to facilitate the growth of the seed industry which will ensure the availability of high quality seeds and planting material to the farmers. It is involved in documentation, indexing and cataloguing of farmers' varieties. The database of all the registered varieties is maintained in a Register known as National Register of Plant Varieties and maintaining National Gene Bank. The same database is also maintained in digital form in e-National register. The Authority confers the "Plant Genome Savior Community Award" annually for farming community based organizations. At individual level, Plant Genome Saviour Farmer Reward" and "Plant Genome Saviour Farmer Recognition" will be given to farmers for conserving agro-biodiversity (PPVFRA Annual report 2014).

National Research Development Corporation (NRDC) was established in 1953 by the Government of India, with the primary objective to promote, develop and commercialize the technologies/know-how/inventions/patents/ processes emanating from various national R&D institutions/ Universities. It is presently working under the administrative control of the Department of Scientific and Industrial

Research, Ministry of Science and Technology. It is recognizing a large repository of wide range of technologies spread over almost all areas of industries, viz. Agriculture and Agro-processing, Chemicals including Pesticides, Drugs and Pharmaceuticals, Bio-Technology, Metallurgy, Electronics, etc. It has licensed the indigenous technology to more than 4 800 entrepreneurs and helped to establish a large number of small and medium scale industries. For encouragement and advancement, meritorious inventions awards, Techno-Commercial support, IPR Protection, Value addition services are provided (NRDC annual report 2015)

Technology Information, Forecasting and Assessment Council (TIFAC) is an autonomous organization set up in 1988 under the Department of Science and Technology to look ahead in technologies, assess the technology trajectories, and support technology innovation by network actions in selected technology areas of national importance. Mainly the technical and financial support is provided in the form of filing patents, extending post patent support for technology refinement and marketing and to upscale through various programmes. These programmes include Patent Facilitating Center (PFC), Technology Refinement and Marketing Programme (TREMAP), and TIFAC-SIDBI Revolving Fund for Technology Innovation Programme. It conducts workshops and training programmes on IPR awareness programmes across the country (TIFAC annual report 2014).

National Bank for Agriculture and Rural Development (NABARD) set up a separate fund titled "Farm Innovation and Promotion Fund" (FIPF) to encourage specifically the innovations in the farm sector. The Fund has been created in NABARD with an initial corpus of 5 crores and it was operational with effect from 1 April 2005. It was initiated mainly to provide support on the analogy of venture capital for innovative ideas – technological and managerial (like supply chain management) in farm sector for further development (NABARD report 2010).

An overview of reasons for slow pace of scaling up of farmer led innovations

Lack of proper documentation: Identification of innovative farmers is not an easy task as it requires a different approach than the traditional survey method. It also requires time, patience and commitment (Akinagbe 2010). Farmers are silently innovating, adopting the new practices and continuously improving them. These farmer-led innovations, over generations, have neither been completely documented nor recognized. Also the Intellectual Property Rights (IPR) on the innovations made by farmers has often been ignored. Value of traditional knowledge and its documentation has often remained unnoticed by scientists. As a result, many technologies developed by innovative farmers have not reached to other farmers (TAAS report 2011). According to Gupta (2013), the government and aid organizations have little consideration in acquiring ideas or innovative products and services designed at the grassroots by the people they are trying to assist. Even if these organizations are incorporating these innovations, one cannot find many

databases, either online or offline, of innovative solutions developed by disadvantaged people themselves. Many times, grassroots innovators don't even know that they have innovated. Scientists around the world have continued to ignore local knowledge and innovations. There is a gap between the formal and informal knowledge production systems, and in the agenda-setting arrangements of formal scientific institutions. Every State Agricultural University publishes its own package of practices but the farmer led innovations cannot find any place in it. There are few opportunities for understanding the real potential of grassroots innovations and the rewards of validating or further developing them may seem limited. The pressure from local innovators and traditional knowledge holders to influence policies is feeble, fragmented and easy to ignore (SciDev Report paper 2007). Brigidletty *et al.* (2012) summarized that there has been even limited responsiveness of scientists to work with innovators as local innovations have restricted vision, limited sources of knowledge and technical potential.

Lack of assistance for validation and commercialization: There are millions of ideas and innovators waiting for assistance in terms of funds, technical and design support. The institutional innovations are validated by multi-disciplinary experts and commercialized at larger scale but there is lack of adequate institutional support to local innovations, as they don't have such set of indicators for validation. According to Olga (2015), the scarcity of financial resources remained a constraint for the commercialization of grass root innovations. There is no proper appreciation of farmers as actors in the innovation system, little information provided about different sources of knowledge involved, or the flow of knowledge and little attention to long-term impacts on livelihoods (Brigidletty *et al.* 2012). Funds crunch, lack of adequate assistance from government officials and private sector firms, and lack of awareness among people have been the main deterrents in making this a national movement and there is a complete lack of interest from the scientific institutions of India to promote rural innovations (Gupta 2010). Very few grassroots innovators could commercialize their innovations by themselves, but for others, there were many difficulties in securing funds to start a business. In addition to high risks and low profit, there is a problem of access to formal funding through financial institutions, and lack of eligibility of grassroots innovators for loans because they do not have the financial guarantees and collateral. Moreover, the organizations that are presently working are not hierarchical, but rather horizontal with networking. Most models of development are centered on what the poor don't have rather than what they have. Some position the poor at the bottom of the economic pyramid, but this does not equate to a lack of knowledge, values and social networks. There is a need to see the poor as a provider than a market with their limited material resources driving knowledge-intensive, informal innovation. Through providing incubation and development support, patent and intellectual property rights assistance,

marketing advice and microventure funding, one should seek to support the creativity that already exists at the grassroots.

Lack of proper dissemination: According to Fetien *et al.* (2009) most of the farm innovators were willing to share their innovations with others, but a few said they would not like to share their innovations until these been recorded as their own innovations. This could be one of the reasons for the slow pace of innovation dissemination. Letty *et al.* (2011) reported that the positive impacts of these farm innovations are not realized by many smallholders whose adoption decisions are hampered by a number of constraints. These local innovations are often location specific, not replicable for other crops or require more complementary inputs. It is also dependent on the innovative farmer contacts with other persons and the distance from the locality (Sunding *et al.* 2000). Akinngbe (2010) pointed out that some people have the tendency to believe that it is only extension workers who could bring something new and important to the farmers. Because of this reason, they do not only provide “no support” but also discourage the innovative farmers, considering them someone wasting time for “no good” reasons. The tradeoff between affordability and accuracy may make a significant difference to the issue of accessibility and effectiveness. Many of the innovators use very old materials and design products using old tools. The materials and publication possibilities has not been ever provided to grassroots innovators (Gupta 2009).

Strategies for scaling up of farmer led innovations

For documentation: There are 642 Krishi Vigyan Kendras (KVKs) in India and every district has at least one KVK. As KVKs are at the district level and in touch with farmers, a network of KVKs can be utilized for documentation of farmer led innovations and maintain a repository at district level. The other permanent feature at district level is ATMA. Hence there should be functional linkage between KVK and ATMA in documentation of grassroots innovations. Besides this, the farmers should be empowered to be in charge of their own documentation of farm level innovations and get through to people at village level.

The new mandate of the present government “Mera Gaon Mera Gaurav (MGMG)” in 2015 envisages scientists of every ICAR institutes, SAUs, KVKs to adopt villages and provide information to the farmers on technical and other related aspects in a time frame. The IARI has adopted 600 villages with 120 teams visiting monthly. This ongoing scheme can also be used to document farmer led innovations across the country and which can be subsequently validated and disseminated.

Social networking sites or launching of innovative farmers portals can be better utilized for documenting of innovations. Maintaining servers and websites for connecting all the organizations which are directly and indirectly involved in promoting farm innovations like ICAR, NIF, PPVFRA, DST, NRDC, etc for maintaining centralized

data base at national level to avoid duplication of efforts. These organizations should create separate web pages of successful innovators of all the areas. Launching of separate network projects or All India Coordinated Research Projects (AICRP) on farmer led innovations may have better impact.

There are many farmers who have benefited by the Honey Bee Network’s open-access database of innovations, but many more can benefit if the database gets translated into different languages and is shared widely through social media channels. Similarly, there is a great deal of folk cultural creativity that deserves to be recognized to maintain the experimental and creative traditions.

The Directorate of Knowledge Management in Agriculture (DKMA) of ICAR can act as a platform for showcasing of farmer-led innovations. It is committed to promote ICT driven technology and information dissemination system for quick and cost-effective delivery of messages to all the stakeholders in agriculture. At present, keeping pace with the current knowledge diffusion trends, Directorate is delivering and showcasing ICAR technologies, policies and other activities through print, electronic and web mode. Directorate is the nodal center for design, maintenance and updating of ICAR website along with facilitation of network connectivity across ICAR institutes and KVKs. Besides, Directorate provides public relation and publicity support to the council and its constituents across the country. So this can be utilized as a hub of information across the nation for wider diffusion of farmer-led innovations.

For validation and commercialization: Farmer-led innovations would often require validation and refinement for which Agricultural Universities and ICAR Research Institutions could provide laboratory equipment and facilities through establishment of referral centers. The validation process requires different level of experts based on type of innovation. Some need laboratory facilities and others can be done through local people. Engaging local people in the validation of innovations at grassroots level generates motivation to the fellow farmers. Benefits of such refined/improved technologies could be shared among the farmer entrepreneurs and the concerned scientists/institutions through commercialization. The creativity of the innovators should be acknowledged and their intellectual property rights should be protected. The institutions should encourage entrepreneurship for the farmer-led innovations.

This, however, will require commitment and greater budgetary support towards innovation systems mainstreaming in all public agricultural extension and research programmes. The private sectors should be engaged for commercialization of replicable innovations.

Farmer Innovation Funds (FIF) can be designed to provide direct, fairly simple competitive access to small grants or loans for individual farmers or farmer groups, businesses, or other stakeholders who wish to adapt, develop, or adopt innovations and business initiatives. Access to such funding allows a wide range of innovations to be tackled, and under proper conditions may expand enthusiasm

and innovation capacity among smallholders, other rural stakeholders, and those who support them. Funding mechanisms can be made more sustainable by linking them with savings and credit schemes and structures by embedding them within existing agricultural R&D institutions and mechanisms for fostering innovation. A national fund is also required under which farmers will have a right to use that fund for conducting experiments which allow farmer innovators to prioritize their own needs.

For dissemination: As the farmer led innovations are location specific, region wise local innovations of a particular zone can be popularized for better dissemination. The existing facility of ATARIs linking with KVKs can assist and having a center for display of region specific innovations. The ATIC (Agricultural Technology Information Centers) working as single window centre and visited by large number of farmers should have the honour board at the entrance depicting the innovators along with their innovations for the benefit of the visitors.

Farmer-led innovations identified in one region need to be popularized in similar eco-regions elsewhere, through publication, documentation and dissemination of Success Stories. The farmers' innovations should be incorporated in "package of practices" of state literature. There is a need to start Front Line Demonstrations (FLD) in innovative farmer fields and experimentation sites to promote farmer to farmer learning. Farms of innovative farmers should be recognized as agri tourism centres to facilitate the visits of other farmers. Agro-tourism around farmers' innovative efforts would not only generate public awareness but will also help in revenue generation and greater community involvement in protecting our rich biodiversity.

Every KVK is organizing pre-kharif and pre-rabi season exhibitions and displaying farmer stalls. This facility can be used to motivate and mobilize innovative farmers at district level to display their innovations and recognizing them with awards. The successful innovative farmers should be invited as a resource farmer in training programmes conducted by KVKs of ICAR and SAUs. Multi-lingual, multimedia kiosks at various public places, educational institutions and local bodies disseminating location specific innovations should be installed. District level institutions should motivate farmers, especially youth about the importance of IPR in the field of innovations.

Conferences, seminars and workshops involving successful innovative farmers to share the experiences for replication and to blend with modern science should be often organized and media campaign must be there to increase visibility of grass root level innovations. The validated innovations should be disseminated through social networks like you tube, twitter, etc for wider coverage. ICAR should provide outstanding awards to the farmers those who follow best innovative practices in all fields and should launch a separate journal for successful innovative farmers for better dissemination.

The policy makers can think of using the innovative farmers as local leaders for spreading of new technologies

as these farmers are easily available to other farmers as per their convenient time and more number of trainings should be conducted for these innovative farmers. Innovative farmer groups should be encouraged in organizing innovation fairs as a way to share their knowledge and achievements. Such fairs offer good occasions for awarding local innovators. They make the general public more aware of and interested in the wealth of innovations in rural communities and can generate public support for such related initiatives. The fairs can also attract tourists and thus contribute to local income and development

There is an urgent need for concerted efforts at village/block, district/national level for horizontal spread of farmer experiences. Farmer-to-farmer extension will create space for innovation because farmers learn best from their peers, and they are often more willing to accept innovations observed in the fields of other farmers than messages disseminated by extension workers. By facilitating the sharing of knowledge, information and technologies between farmers, and institutions especially, the farm innovations will be up scaled and out scaled. As all the institutions working independently at their own resources and plan of activities and operation, there should be a networking between institutions at national level, working on this farmer led innovations. Based on the review collected from different research findings, a model is proposed in Indian perspective for scaling up of farmer led innovations.

Establishment of a "National Innovation Centre" at ICAR headquarters linking all 8 ATARI with ATMA and KVKs as partners for documentation, refinement, validation, commercialization and scaling up of innovations can be the crucial step at apex level.

Innovation Knowledge Management Unit (IKMU), collaborating ICAR, NIF, PPVFRA, NABARD and other related organizations need to be established under National Innovation Centre for maintaining a national database repository of farmers' innovations. Separate cells performing various functions such as validation, consultancy services, human resources (HR), project cum commercialization and dissemination should be created. The existing facility of ICARs Zonal Technology Management and Business Planning and Development units (ZTM and BPD), which are mainly providing support to incubates, can act as a referral center of the institute to perform validation and commercialization of farmer led innovations. Zonal wise established ATARIs can assist in providing consultancy services, building human resources and disseminating activities by display of farmer led innovations at respective zones. And the district level institutions like KVK and ATMA act as a link between farmers and the center. It is also proposed to appoint farmers as members in NIC for effective linkage and feedback. The center should act as a 'One stop shop' center for all the information.

Farmers' innovations are a product of farmers' informal experimentation. Although farmers' innovation has always been happening but quite slowly and has seldom been recognized by communities itself and the scientist also. There

are many innovations in isolated pockets having wide range of implications and need to be refined by research system for up scaling/out scaling. It is therefore, necessary to develop a platform for farmer-scientist-institution interface to recognize the importance of farmer-led innovations and identify ways to upscale them. The innovation process at farmers could be speeded up giving opportunity and promoting entrepreneurship to bring in their ideas and skills. The capacities and potential contributions of the farmers must be valued. Recognizing the innovativeness of farmers creates fertile ground for their collaboration with other actors in innovation systems. Innovation should be the vital element for startup agri India. In this context networking of different organizations who are involved in promoting farmer led innovations has a real opportunity to respond to this need.

REFERENCES

- Abdullahi, Garforth C J and Dorward T. 2014. Enhancing farmers-led innovation processes in Sub Sahara Africa: A case study of Nigeria. *International Journal of Agriculture Innovations and Research* 2(4): 480–90.
- Akinagbe O M and Ajayi A R. 2010. Challenges of farmer-led extension approaches in Nigeria. *World Journal of Agricultural Sciences* 6(4): 353–59.
- Gupta Anil. 2009. Managing knowledge, creating networks and triggering innovations for sustainable agriculture. Paper invited for National Seminar on Agriculture Extension, Ministry of Agriculture, New Delhi.
- Gupta Anil. 2010. Finding Innovation in Every Corner. The Design Observer Group.
- Gupta Anil. 2013. Tapping the Entrepreneurial Potential of Grassroots Innovation. Stanford Social Innovation Review. Sponsored Supplement. Rockefeller Foundation.
- Ann Waters-Bayer, Patti Kristjanson, Chesha Wettasinha, Laurens van Veldhuizen, Gabriela Quiroga, Kees Swaans and Boru Douthwaite. 2015. Exploring the impact of farmer-led research supported by civil society organisations. *Agriculture and Food Security Journal*. 4:4.
- Bayer S. 2013. What determines innovation capacity in farm households? Insights from rural Ghana. https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=CSAE2014&paper_id=391.
- Brigidletty, Zanele Shezi and Maxwell Mudhara. 2012. Agricultural grassroots innovation in South Africa: Implications for indicator development. Ideas for new research projects on LICS in Africa. African Globelics Seminar, Tanzania.
- Business standard. 2014. http://www.business-standard.com/article/current-affairs/india-s-population-at-1-21-billion-hindus-79-8-muslims-14-2-115082600038_1.html
- Census 2011. Census of India report. <http://censusindia.gov.in/>
- Central Statistics Office. 2015. <http://pib.nic.in/newsite/PrintRelease.aspx?relid=113870>
- Claire G, Suresh Babu and Kwadwo Asenso-Okyere. 2010. Review of Agricultural Extension in India: Are Farmers' Information Needs Being Met? IFPRI Discussion Paper 01048. Eastern and Southern Africa Regional Office.
- Devinder S. 2014. Agriculture in terrible crisis: Indian farmers are struggling to survive. Vision to action: A sector strategy. GRAIN Bulletin Board report on Agriculture.
- Economic survey. 2014. <http://pib.nic.in/newsite/PrintRelease.aspx?relid=116059>
- European Union report. 2011. Recognising the unrecognised: Farmer innovation in northern Malawi: Find your feet. The Development Fund.
- FAO (Food and Agriculture Organization). 2007. Agricultural workers and their contribution to sustainable agriculture and rural development. http://www.fao-ilo.org/fileadmin/user_upload/fao_ilo/pdf/engl_agricultureC4163.pdf
- Fetien and Tesfahun Fenta. 2009. Training local innovators in Farmer-Led Documentation in Ambo, Ethiopia. Report on FLD. PROLINNOVA –Ethiopia.
- Gildemacher P, Maina P, Nyongosa M, Kinyae P, Woldegiorgis G, Lema Y, Damene B and Oriz O. 2009. Participatory analysis of the potato knowledge and information system in Ethiopia, Kenya and Uganda. *Innovation Africa: Enriching farmers' livelihoods*. Earthscan: London: 153–65.
- ICAR report. 2015. <http://www.icar.org.in/en/node/9925>
- ICAR Vision 2020. <http://www.icar.org.in/files/vision-2020.pdf>.
- Jyotika S. 2014. India's deepening farm crisis: 76% farmers want to give up farming. Down to Earth report.
- Kokate K D, Kharde P B, Patil S S and Deshmukh B A. 2009. Farmers' - led extension: Experiences and road ahead. *Indian Research Journal of Extension Education* 9(2): 18–21.
- Kolade O and Trudy Harpham. 2014. Impact of cooperative membership on farmers' uptake of technological innovations in Southwest Nigeria. *Development Studies Research* 1(1): 340–53. Available online at <http://dx.doi.org/10.1080/21665095.2014.978981>
- Kummer S. 2011. Organic farmers' experiments in Austria. Learning processes and resilience building in farmers' own experimentation activities. Doctoral thesis, University of Natural Resources and Life Sciences, Vienna.
- Leitgeb F, Kummer F, Funes- Monzote F R and Vogl C R. 2013. Farmers' experiments in Cuba. *Renewable Agriculture and Food Systems* 29: 48–64.
- Letty B, Noordin Q, Magagi M and Waters-Bayer A. 2011. Farmers take the lead in research and development. (*In*) The Worldwatch Institute- State of the World 2011: Innovations that Nourish the Planet. The Worldwatch Institute, Washington DC.
- Mariam A T J, Johann Kirsten F and Ferdinand Meyer H. 2011. Agricultural rural innovation and improved livelihood outcomes in Africa. *Proceedings of the Forum on the Development Southern Africa*.
- Morris M L, Kelly V, Kopicki R J and Byerlee D. 2007. Fertilizer use in African agriculture: Lessons learned and good practice guidelines. World Bank, Washington DC.
- NABARD Report. 2010. Farm Innovation and Promotion Fund. Available at https://www.nabard.org/english/Policy_Programmes.aspx
- NIF. 2015. National Innovation Foundation Report, 2015. Available at <http://nif.org.in/aboutnif> and <http://nif.org.in/sd>
- NRDC annual report. 2015. <http://www.nrdcindia.com/english/index.php/about-us/about-nrdc>
- OECD/Eurostat. 2005. Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, Paris: OECD.
- Olga V Ustyuzhantseva. 2015. Institutionalization of grassroots innovation in India. *Current Science*, vol 108. No. 14768, 25.
- PIB (Press Information Bureau). 2015. Available at <http://pib.nic.in/newsite/PrintRelease.aspx?relid=113870>
- PPVFRA Annual Report, 2014. Available at: http://www.plantauthority.gov.in/pdf/E_Annual%20report%202013-14.pdf

- Prachi. 2014. How many farmers does India really have? <http://www.hindustantimes.com/india/how-many-farmers-does-india-really-have/story-431phtct5O9xZSjEr6HODJ.html>
- Prolinnova- Ethiopia progress report. 2006. Unpublished report Prolinnova. 2004. Annual Report. Prolinnova Secretariat, Leusden.
- Prolinnova. 2009. Notes on local innovation and participatory innovation development, Available at: <http://www.prolinnova.net>.
- Sainath P. 2013. The Hindu report on agriculture. Over 2,000 fewer farmers every day. <http://www.thehindu.com/opinion/columns/sainath/over-2000-fewer-farmers-every-day/article4674190.ece>
- SciDev Report paper. 2007. Bringing science and development together through original news and analysis.
- Singh R P. 2013. Farmer led extension: Concept. <http://www.slideshare.net/rpratap11/farmer-led-extension-i>
- Soedjana T, Kristjanson P and Pezo D. 2015. Ex post impact assessment of technological interventions. Module 8: Center for Agricultural Library and Research Communication, AARD, West Java, Indonesia. <http://www.ilri.org/InfoServ/Webpub/fulldocs/CanthoManual/module8.htm>.
- Spielman D J. 2009. The art and science of innovation systems inquiry: Applications to Sub-Saharan African Agriculture. *Technology in Society* 31(4): 399–405.
- Sule Akkoyunlu. 2013. Agricultural Innovations in Turkey. Swiss National Science Foundation under a grant to the National Centre of Competence in Research on Trade Regulation, University of Bern, Switzerland. NCCR Trade Working Paper No. 30.
- Sunding D and David Zilberman. 2000. The agricultural innovation process: Research and technology adoption in a changing agricultural sector. *Handbook of Agricultural Economics*. University of California, Berkeley.
- Suresh B. 2014. Feeding a billion: Agriculture and food security in India. Publication produced by NBR for the Senate India Caucus <http://nbr.org/research/activity.aspx?id=402>
- TAAS (Trust for Advancement of Agricultural Sciences) Report. 2011. Proceedings of the National workshop on Farmer-Led Innovations. Haryana Kisan Ayog. Hisar, Haryana.
- Tambo A Justice. 2014. More than adopters: the welfare impacts of farmer innovation in rural Ghana. Selected Paper prepared for presentation at the Agricultural and Applied Economics Association's, AAEA Annual Meeting, Minneapolis.
- TIFAC annual report. 2014. <http://www.tifac.org.in/images/pdf/annual%20report/AR2013-14.pdf>
- Times of India. 2013. Farmer population falls by 9 million in 10 years. <http://timesofindia.indiatimes.com/india/Farmer-population-falls-by-9-million-in-10-years/articleshow/19813617.cms>
- UN (United Nations). 2007. Report on Global Employment at Work. Available at <http://www.un.org/esa/socdev/rwss/docs/2007/chapter1.pdf>
- UN (United Nations). 2008. Innovation for sustainable development: Local case studies from Africa. Division for Sustainable Development. United Nations: New York.
- UN (United Nations). 2015. World population prospects. Key findings and advance tables. Department of Economics and Social Welfare Population Division. New York.
- Wettasinha C, Waters-Bayer A, van Veldhuizen L, Quiroga G and Swaans K. 2014. Study on impacts of farmer-led research supported by civil society organizations. Penang, Malaysia: CGIAR Research Program on Aquatic Agricultural Systems. Working Paper: AAS- 2014-40.
- Wettasinha C, Wongschowski M and Waters-Bayer A. 2008. Recognising local innovation: experience of PROLINNOVA partners. Silang, Cavite, the Philippines: International Institute of rural Reconstruction / Leusden: PROLINNOVA International Secretariat, ETC EcoCulture.
- Wolf S A .2008. Professionalization of agriculture and distributed innovation for multifunctional landscapes and territorial development. *Agriculture and Human Values* 25 pp 203-07.
- World Bank. 2004. Promoting local innovation: enhancing IK dynamics and links with scientific knowledge. IK Notes 76 (<http://www.worldbank.org/afri/ik/default.htm>)
- World Bank. 2005. Innovation Support Funds for Farmer-led Research and Development. IK notes. No. 85. <http://www.worldbank.org/afri/ik/iknt85.pdf>
- World Bank. 2006. Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems. World Bank, Washington DC.
- Wunscher T. 2014. More than adopters: the welfare impacts of farmer innovation in rural Ghana. Selected Paper prepared for presentation at the Agricultural and Applied Economics Association's, AAEA Annual Meeting, Minneapolis.