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Developing Model for Diffusion of Farmers' Innovations for Maximizing Farm Income: Indian Agricultural Research Institute Experiences

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ABSTRACT

Indian farmers have also been continuously improving available technologies for more efficient and cost effective farming, which resulted in numerous innovations over the generations and helped in improving farming practices ensuring better livelihood options. The action research was carried from 2015 to 2021 to document, verify, scalability testing, developing sharing and scaling mechanism, identifying support mechanism and finally devising scaling mechanism for higher profits, reduced costs, enterprise development, enhanced employment opportunities and capacities, growth and survival. The results of various interventions showed that FLIs were mostly reconfiguration of existing resources giving incremental adjustments. All innovators studied expressed dissatisfaction with the pre-existing economic returns of the farming thus pushing them to innovate. Economic effect of the farmers' innovations in terms of changes in income, change in savings of stakeholders, change in capital owned and change in credit availability were expressed on an average. The innovations which were economically viable and found sustainable source of funding were able to translate into entrepreneurial ventures having higher income and profits. The conceptual model for scaling farmers' innovations was found effective on the basis of experiences and interventions.

INTRODUCTION

In the 1940s, biologists began developing high-yield varieties which paired with new fertilizers and pesticides, dramatically transformed the way we are able to eat today as the amount of food harvested per unit area increased manifolds. These science-based technologies triggered changes in agriculture and ultimately pressure on natural resources, including land and water, leading to compromised sustainability of agriculture, to cope with, small-scale producers need to continuously innovate to adapt to the changing environment and changing markets. Production systems will have to become more resilient, and technology for development must go well beyond raising yields to saving water and energy, reducing risk, improving product quality, protecting the environment, and tailoring to gender differences" (World Bank, 2008). Innovation processes are looked at nowadays from an evolutionary perspective, that a variety of innovations and innovation processes compete in a dynamic selection environment in which the 'best fitting' survives in a given time and space context (Bijker et al., 1987; Rotmans et al., 2001). Clearly, such 'fitting' does not just involve adaptation to prevailing contextual conditions, but also the active influencing, re design or destruction of pre existing conditions and frameworks, respectively the 'overthrowing' of previously dominant 'socio technical regimes' (Geels & Schot, 2007).

Innovations from R&D system play an important role in optimizing resource utilization but apart from systematic experimentations innovations in the form of grassroot level technologies and methodologies developed by some of the

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innovative farmers are benefiting widely to farmers. Such innovative technologies and methodologies are largely confined to some locations. As per social learning framework strategy proposed by Noguera et al., (2016), pro-environmental values and intentions with time as a determinant factor in the social learning process play role while trying to change values and attitudes through dissemination of innovations. Reij & Waters-Bayer (2001) suggest participatory approaches to agricultural research that build on local knowledge and innovation can stimulate and diffuse innovation capacity among farmers and external scientists. Farmers' innovation in the context of sustainable agricultural and natural resource management can lead to innovative ways of reducing dependence on external inputs. Innovative techniques often represent adaptation of existing knowledge as their development is mostly through local creativity. Such innovations having additional advantage over conventional innovations to tackle second generations' problems require different set of capacities on the part of farm innovators to scale their innovations in addition to be innovative, learning institutes for which are yet to be come into existence. (Nain et al., 2018).

As such the benefits accrued from such innovative ideas need to be widely shared across the sections and the scientific talents behind such farmers' level innovations need to be encouraged and recognized. Valuable ideas and techniques generated by them largely go unnoticed owing to lack of proper documentation and opportunities for wider dissemination as the geographical proximity is significant and positively affecting knowledge exchange within the *informal advice network,* but not important in the formal AKIS (Kabirigi et al., 2022). In the same wake a framework was conceptualized at Indian Agricultural Research Institute, New Delhi to institutionalize such farmers' innovative ideas was conceived and systematic investigation methodology was adopted.

METHODOLOGY

In order to develop the model for replicating farmers' innovations and making farming a business venture, an action research study has been conducted. The farmer led innovations were identified, documented, tested their scalability and the action interventions at small scale were conducted in three NCR Delhi villages namely *Fatehpur Biloch (Faridabad), Manjhawali (Faridabad)* and *Swamika (Palwal).* At first stage 135 farmers and farm women (45 from each village) were identified to analyse the perceived role of support system in innovating and enhanced farm profitability. Later on small scale interventions were also laid out with these selected respondents. Two farm innovators' meet at IARI, New Delhi and 5 farm innovators' meet at Agricultural Technology Application and Research Institute (ATARI) level at Raipur (ATARI, Jabalpur), Bareilly (ATARI, Kanpur), Baramati (ATARI, Pune), Patna (ATARI, Patna), and Udaipur (ATARI, Jodhpur) were organized from 2015 to 2020 in order to create bank of the grass root innovations of farmers and their experiences with validation of farmers' innovations and linkage mechanism, screening the innovations on scalability criterion, creation of social network of farm innovators and scientists of the zone, and devising framework for promotion of farmers' innovations. To measure the scalability of farmers' innovations, 24 bipolar statements under seven major dimensions were devised and measured accordingly. In total 649 such innovative farmers with their improved practices were documented over a period of seven years. The innovations documented were classified in; niche agricultural areas, innovative crop and animal husbandry methods, horticultural innovations, farm diversification, integrated farming, conservation agriculture, land development and management, post harvest processing, farm machinery and custom hiring centre and innovative packaging & marketing innovation (Table 1). The efforts to understand various dimensions in scaling innovations were made through constraint analysis, drawing lessons from interactions, studying content sharing through WhatsApp group, scalability analysis of identified innovations, studying role of institutional arrangements, benefits accrued through collectivization, pre and post intervention comparison of competencies and linkage network analysis.

Table 1. Analyzed Farmers' innovations

S.No.	Type	Number
1.	Niche areas (Protected cultivation, fishery, Apiary, mushroom production, seed production, organic production etc.)	149
2.	Innovative methods of crop and animal husbandry	112
3.	Horticultural innovations	74
4.	Diversification	88
5.	Integrated farming	42
6.	Conservation agriculture, land development and management	59
7.	Post harvest processing	55
8.	Farm machinery and custom hiring centre	52
9.	Innovative packaging and Marketing innovation	18

RESULTS

Why farmers' innovations?

Figure 1 & 2 clearly demonstrate that the strengthening institutional & individual capacities for scaling up technologies, facilitation of networking amongst extension service providers & farmers in the region, mobilising and allocating resources for scaling up of technological activities and facilitating the sharing of available knowledge on new technologies & innovations were the major determinants of maximizing farm income, whereas, regarding the perceived role of support system in innovating and enhanced farm profitability; market support system, financial institutional support system, informal networking, incentives & policies, technological backstopping and social acceptance & social support system played a major role.

Fuentes et al., (2013) suggested that private players should assist in the commercialization of farmer-led innovations. Farmers should play a key role in planning the process of scaling out in their area to develop ownership and commitment to improving livelihoods. Supporting organizations need to facilitate the scaling out process beyond short term research or development projects (Miller & Connell, 2009). As such a study was conducted to find out the capacities requirement and the criterion for scalability of farmer led innovation as perceived by the farmer stakeholders. Table 2 shows that on the basis of 649 farmers' innovations, it may be inferred that relevancy**,** relative advantage over existing practices,

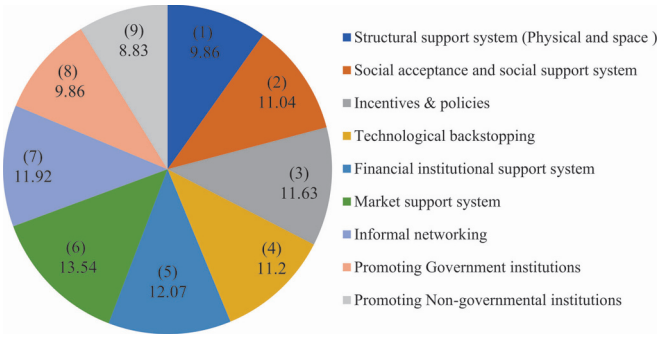

Figure 1. Perceived role of support system in innovating and enhanced farm profitability

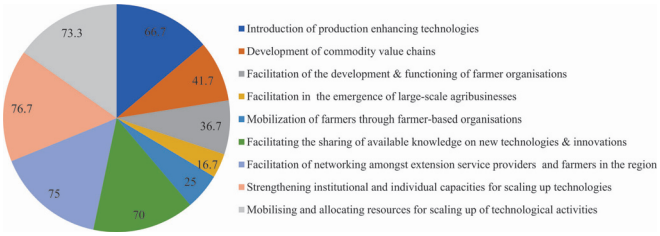

Figure 2. Perceived determinants for maximizing farm income

and the observable results were major characteristic favouring the scalability of the innovations. These are in line with the established theory of diffusion of innovations as founded by Rogers (2003). Most of the innovations that were showcased and documented were simple, made using locally available materials but were very well replete/punctuated with interesting ideas and science. Lots of the innovations were results of extremely hard-working and dedicated individuals and involved many hours of work that they largely did themselves.

Farm innovators' meets and interactions

In order to scale farmer led innovations, the farmer innovation fair (FIF) methodology grew out of a series of fairs organised in different countries. FIF involves creating a space to bring farmer innovators together and to provide them with an opportunity to display their work and to interact with each other as well as with formal research system and the wider public who visit the fair. But the scarcity of financial resources remained a constraint for the commercialization of grass root innovations (Olga, 2015). 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). Institutionalization of any FLI is a complex process that requires capacity strengthening and change in individuals as well as change in organizations. Baliwada et al., (2017) concluded that few institutions were working for promotion of innovations but there was lack of convergence of activities between these institutions to share the resources and capital. It was also reported that the commercialization depended on many factors like feasibility and significant economic impact of the innovations. It involved several different types of organizations with different cultures, regulations

Table 2. Perceived characteristics of the farmers' innovations for scaling up

S. No.	Parameters	Mean weighted score
a.	Credibility	5.95
1	Based on sound evidence	6.2
2	Can be subjected to independent external evaluation	5.6
3	Capable to work in diverse social & situational contexts	6.4
4	Supported by eminent individuals and institutions	5.0
5	Implementable within existing systems & infrastructure	6.8
6	Small deviation from current practices of perspective adopters	6.2
7	Involvement of less number of people in adoption decision	5.8
8	Low technical sophistication of the components and activities	6.0
9	Clear and easily replicable	5.6
b.	Complexity vs Simplicity	6.2
1	Simple with few components	6.3
2	Easily added or adjusted on to existing systems	6.1
c.	Testability	5.6
1	Able to be tested by users on a limited scale	5.8
2	Little supervision and monitoring	5.3
3	Not particularly value or process intensive	5.7
d.	Observable results	6.43
1	Very visible and tangible impact to casual observation	6.7
2	Clearly associated with the intervention	6.4
3	Evidence and documentation exists with clear emotional appeal	6.2
e.	Relevancy	6.75
1	Addresses an objectively significant, persistent problem	6.7
2	Addresses a need which is sharply felt by potential beneficiaries	6.8
3.	Relative advantage over existing practices	6.65
4	Current solutions for this issue are considered inadequate	6.7
5	Superior effectiveness to other established options	6.6
f.	Sustainable source of funding	5.93
1	Superior cost-effectiveness to existing or other solutions clearly established	6.2
2	Does not require a large commitment of funds at scale	6.1
3	Scope for its own internal funding (user fees) or endowment	5.5
	Overall	6.33

and procedures, which need to learn how to collaborate. In each organization, change has to take place through all layers. As such it was conceptualized (Figure 3) to organize innovative farmers, researchers, research managers, marketing representatives meets at regional level to understand the total perspective of such innovative farmers, their knowledge, opportunity to interact with each other, formation of social media platform for interactions and so on. The initiative was intended to enhance awareness of the innovative capacities of the farmers, to identify farmer-led innovations having potential to be adopted for larger impact and to share the experiences of farmers-led innovations in the field of agriculture and allied sector. With the experiences of first two interaction meets organised few learning were drawn like; with the huge network of Krishi Vigyan Kendras and ATARIs innovations can be tested,

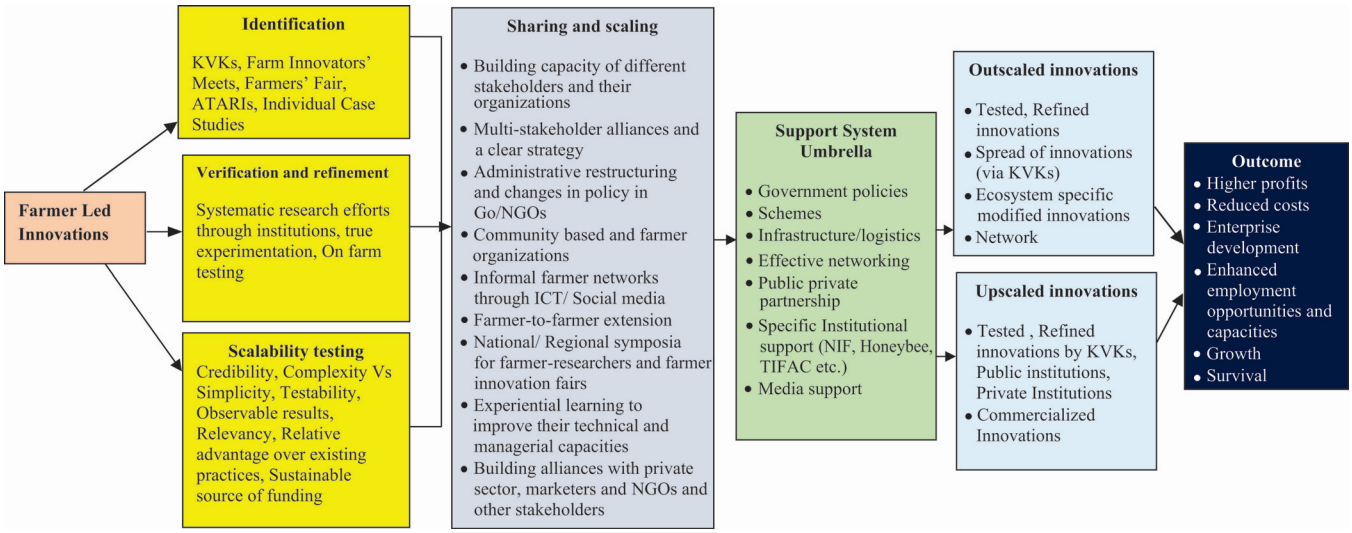

Figure 3. Conceptual Model of Scaling Farmers' Innovations

verified and institutionalized, social media can be used for farmers to farmer interaction on innovative issues, creation of effective alliance of farmers with a mixture of traditional knowledge, farmers' innovations and scientific knowledge, more institutional arrangements to initiate collective production processes, networking mechanisms of stakeholders and popularizing the identified innovative technologies through documentation, publication, success stories and dissemination in different ecosystems. With the initial experiences several initiatives were taken in the form of experimental interventions. The major one included the creation of social media platform through WhatsApp and analysis of content sharing pattern, documentation of innovative farmers' success stories in the publication form, inclusion of few innovative farmers in IARI outreach programme to facilitate transfer of technologies, devoting separate session in Pusa Krishi Vigyan Mela for innovative farmers, linking farmers with public sector seed production corporation and so on. After initial two meets the umbrella was ouscaled to ATARI level and five such meets were organized in overall the initial interventions were expanded at ATARI level and overall several lessons were learnt. The systematic analysis of the content shared the social media platform showed that most of the content shared was knowledge intensive with a mix of personal farming experiences (Table 3). WhatsApp being the potential source for socialization and internalization promoted the creation of social wealth in the form of discussion forums of Innovative farmers for learning exchange. The extension mechanism for purposeful farmer to farmer learning exchange has been created which in turn is a step towards innovative farmer led extension delivery mechanism. The experiences of explorations and action interventions showed that human resources base in rural ecosystem was found lacking in social processes of group and enterprise management skills along with marketing and communication skills. The capacity building interventions not only helped in changing entrepreneurial competencies but broadened the horizon of the participants to launch their own income generating activities. The backward and forward linkages in the form of advisory services, input supply, marketing of the produce, financial backstopping was at a fairer level and the support and convergence of various stakeholders like banks, NGOs, research institution, state line department brought positive impact in the form of initiation of income generating activities. The strength of convergence has already been stressed and found effective (Singh et al., 2014; Gupta et al., 2014; Singh et al., 2016).

Lessons Learnt and way forward

The constraints perceived by 649 farmers in scaling their innovations were studied (Table 4) and found that economic and administrative constraints dominated. The constraint analysis and the experiences sharing of the innovative farmers helped in drawing actionable policy issues. Some of the actionable points aroused include; Establishing and maintaining a database (including physical library) of available technologies, innovations and all sponsored/ unsponsored reports and publications; Establishing and maintaining

Table 3. Content analysis of the information sharing on social network (January 2016 to March 2021)

S.N.	Aspect	Messages in number	Average/ week	Percentage
1	Total number of messages	6792	24.97	-
2	Unrelated	1656	6.08	24.39
3	Comment on Agriculture related messages (for extra information, likes, thanks etc.)	875	3.21	12.87
4	Agriculture related messages	4261	15.66	62.74
A	Success story/photographs	945	3.47	13.92
B	News story/news item (technology, government scheme, plant protection, new methods, seeds, availability of planting/seed material, organic production, marketing information, cultivation practices of different crops etc.)	1495	5.49	22.02
C	Hyperlinks	310	1.14	4.57
D	Videos (machinery, process, working)	1511	5.55	22.25

Table 4. Constraints perceived by farmers in scaling innovations

S. No.	Constraint	Mean score (Three continuum)
a	Technical constraints	2.27
1	Scouting and identification problem	1.92
2	Poor technical competence	2.15
3	Require more complementary inputs	2.31
4	Lack of extension backup	2.05
5	Lack of role clarity of stakeholders	2.60
6	Location specificity of the innovations	2.62
7	Illiteracy of the innovators	2.09
8	Lack of separate staff	2.45
b	Infrastructural constraints	2.12
1	Lack of transport and poor communication	1.85
2	Lack of skilled workers	1.99
3	Lack of regular training for up gradation	2.05
4	Lack of group approach	2.15
5	Lack of IT infrastructure	2.33
6	Lack of testing facilities	2.48
7	Lack of design support for refinement	2.52
8	Lack of expertise for validation	2.61
c	Economic constraints	2.54
1	Lack of subsidy	2.74
2	Untimely release of funds	2.22
3	Lack of timely supply of inputs	2.33
4	No insurance coverage	2.65
5	Lack of separate price policy of the government	2.71
6	Lack of separate budget of the government	2.71
7	Disagreement in sharing of benefits of innovator and organization	2.25
8	Non-availability of commercializing partners	2.72
d	Administrative constraints	2.31
1	Political interference	1.85
2	Job insecurity in contractual staff	2.68
3	Shortage of staff and frequent transfers	2.40
4	Poor monitoring and coordination	2.12
5	No standard set of indicators for validation	2.05
6	Lack of separate cell/staff for innovations	2.70
7	Work overload and involvement in non-agricultural work	2.56
8	Lack of networking between organizations	2.15
	Overall	2.31

a meta-database of agricultural information and means for facilitating it to act as a platform for exchange of information and experiences; Developing and disseminating theme-based knowledge products (posters, radio and TV messages, pamphlets, etc.); Publishing lessons learnt (Print as well as electronic) from development and adoption of innovation activities; Undertake an analysis of partner institutions to assess their potential as participants in maximizing farm profits as primary information centers; Building capacity of partner institutions (both human and infrastructure) to enable them become functional primary information centers as well as active partner; Developing of institutional policies and quality assurance protocols; and facilitating a strong network of Innovative Farmers for the purposes of learning exchanges and up scaling and out scaling their innovations.

DISCUSSION

A skilled workforce is always necessary to continue fast-paced growth and pull millions out of poverty. There was a need of 129.79 million skilled workforce by 2022 in 24 key sectors like agriculture, food processing, handloom etc. But only 4.69 per cent were undergoing formal skill training (NSSO, 2011-2012). Agriculture sector alone required the 24.8 million in 2022 (National Policy on Skill Development and Entrepreneurship, 2015). In agriculture sector only 18.5 per cent of workforce is skilled, of which 0.5 per cent have formal technical education (IAMR, 2013). The innovations led by farmers have neither been institutionalized for their horizontal and vertical expansion nor properly recognized. As a result, many technologies developed by innovative farmers have not reached to other farmers. FLIs having additional advantage over conventional innovations to tackle second generations' problems require different set of capacities on the part of farm innovators to scale their innovations in addition to be innovative, learning institutes for which are yet to be come into existence. (Nain et al., 2018; Nain et al., 2019). Although, the initiative in the form of protection of propriety rights of the farmer-led innovations by government and non-government bodies have been taken in recent past but at a limited scale.

This initiative was intended to enhance awareness of the innovative capacities of the farmers, to identify farmer-led innovations having potential to be adopted for larger impact and to share the experiences of farmers-led innovations in the field of agriculture and allied sector. It was highlighted that identification of innovative farmers is not an end in itself, but how these farmers can be supported in improving their works and help them ensure sustainable livelihood and how best the spirit of innovativeness among the smallholder farmers can be cultivated. It was stressed that there is great need for developing a closer network of all innovative farmers among themselves and also with the researchers. Innovative ways to increase production, improve organisation, or reduce dependence on external inputs, farmer innovations were found having significant potential to improve the quality of life for farming families in Malawi and reduce their impact on the environment. The farmer led innovations are driven by a range of interlinked factors: economic factors (the inability to afford external inputs or grow enough food to be food secure), environmental factors (the need to adapt to climate fluctuations or restore infertile soils which cannot be rested due to small landholdings), social factors(migration, HIV /AIDS, and scarce labour availability), cultural factors (need to use certain plants for ritual and other purposes), and political factors (availability of subsidized fertilizers and seeds as a form of political patronage by a neo- patrimonial state) (FAO, 2012). In the farm sector, determinants of entrepreneurial success turnover (.019) and annual income plays major role in enterprise development (Kobba et al., 2020). Hence the conceptual model proposed to scale the farmers' innovation (Figure 3) may act as a guiding tool.

CONCLUSION

Farm Innovators could have effectively become consultants and entrepreneurs leading to off- farm income generation options but

the lack of proper sustenance support, institutional requirements for scaling and related constraints hindered farmer to farmer extension, institutionalization of such innovations and their blending with the modern scientific knowledge for the benefit of farming community at large. Institutional mechanism and human mobilization for networking and resource optimization, collectivization, technologies and methodologies of secondary agriculture are the keys for maximizing farm income. Human resources base in rural ecosystem in general is lacking in social processes of group and enterprise management skills along with marketing and communication skills. The capacity building interventions not only have the potential for changing competencies but broadening the horizon of the participants to launch their own income generating activities. Research and Development of FLIs to become commercially viable technologies in particular ecosystem and farmers in each strata would go a long way towards farmers led sustainable agricultural development of the nation.

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