Indian J Dairy Sci 77(1): 84-90
https://doi.org/10.33785/IJDS.2024.v77i01.012

RESEARCH ARTICLE

Multi-stakeholders' perception in popularization and dissemination of Farmer-led Innovations in Northern India

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Received: 25 May 2023 / Accepted: 01 August2023 / Published online: 23 February 2024

Abstract: Agro-ecosystems are subjected to a variety of biotic and abiotic challenges, particularly in developing nations. Farmers' innovations are more quickly adopted by other farmers since they are affordable, accessible, locally relevant, and proven in a real farm setting. The proposed study was conducted in Haryana and Punjab, as these two states hold the greatest number of innovative farmers in India in dairy sector as compiled from different secondary sources (ICAR, NIF, NRDC, TIFAC, NABARD). Each state had two districts chosen at random. A sample size of 70 dairy farmers from each district and 20 Research and Development sector persons (public and private) were selected, thus constituting a sample size of 360 for the study. Exploratory factor analysis (EFA) was carried out using IBM SPSS 20 and the principal component analysis (PCA) using oblique rotation technique. The final regression model explained 74.60% of the variation and was significant ($P > 0.001$). Weighted Mean calculation was done to know how the stakeholders perceive the importance of different attributes of FLIs. Stakeholders were giving prominent importance to the costs of the innovation followed by the proper documentation of the innovations by any sort of internal/external agencies. Our results show that farmer-led innovations generally have a positive effect on welfare, which is consistent with growing arguments that these innovations which have often received less attention than externally pushed technologies should be encouraged as a supplement to efforts to improve food security and eradicate rural poverty.

Keywords: Perception; Stakeholder; Innovation; Scaling up; Diffusion

Introduction

Research and development (R&D) efforts have led to new ideas, innovations, products, and technology that have significantly shaped agriculture and related industries, with a high social rate of return to investments made (Alston, 2010). However, the results of these initiatives won't be fully realized until the farming community has access to the new information and tools with their ability to connect with the knowledge, institutions and networks, essential to improve their food security, productivity and livelihood opportunities (World Bank, 2011). The links between innovation development to its dissemination, users and support mechanisms must therefore be strengthened in order to facilitate the generation and transfer of innovations. This creates a networking system among all stakeholders that results in a dynamic innovation system.

Innovations in various production methods, markets, and related activities are important drivers of agricultural growth and the advancement of its inclusivity. An idea, behaviour, or other phenomenon that a person or other unit of adoption sees as novel is referred to as an innovation (Rogers, 1963). Innovation has been a lynchpin of Indian agriculture since the dawn of time, and Indian producers are no exception. Farmer-led innovations are those that are created, developed, or tested by a farmer or group of farmers on their own or using ideas from outside sources without the direct assistance of outside agencies or recognized academic institutes (Sule Akkoyunlu, 2013, Wettasinha *et al.* 2008;). Farmers have developed a number of grass-roots improvements over the course of evolution that have increased their profits and turned farming into a viable industry. Farmer-led innovation, in which farmers take the initiative to create new knowledge, technology, and working methods, is increasingly recognized as being crucial to assuring the farming industry's social, economic, and environmental sustainability (Ensor and

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Bruin, 2022). Farm innovators are those who frequently address regional difficulties and generally labour outside of established organizations (European Union, 2011; Olga, 2015; Prolinnova, 2009). The participatory farmer-led techniques in which the farmers acquire and implement the good practices from their peer group, which in turn motivates and empower them to regain control, indicating their effectiveness for generating greater prosperity and welfare. Indian farmers continuously work to make farming more efficient and economical in an effort to raise their standard of living, and these inventions over time served to enhance farming practices and provide better living possibilities. In reality, according to Roling (2009), farmers have been developing new technologies even before official scientific research for development emerged. According to some studies, some scientifically developed technologies were truly based on agricultural innovations made by local farmers. In this context, we have tried to access the multi-stakeholders' perception in the concerned study area.

Materials and methods

Haryana and Punjab states were purposively selected considering their prominence in the number of innovative farmers related to the field of dairying (ICAR, NIF, PPV &FRA, NRDC, TIFAC, NABARD, 2018). From each state randomly two districts were selected. As a whole, a total of four districts were selected. From each district, two blocks were randomly chosen comprising eight blocks as total. From each block 35 dairy farmers were selected comprising a total of 280 dairy farmers as sample. Apart from that 10 government R&D (research and development) persons and 10 private R&D persons related to the field of dairying were selected from the district level. So, a total of 280 dairy farmers and 80 R&D persons (both public and private) were selected as complete sample for the study. 360 samples in total were therefore chosen. A regression analysis was performed to understand the factors impacting innovativeness, with innovativeness as the dependent variable.

$$y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \varepsilon$$

Where α is the intercept, β_i's are the slope between y and the appropriate independent variable x_i , and õ is the error term. Perceptual attributes of the identified Farmer-led Innovations were measured with 37 items covering the aspects of relevancy, profitability, sustainability and adaptability. The weighted mean of the perception scale statements is calculated by multiplying the weight with the quantitative outcome and adding all the products.

Results and Discussion

Innovativeness is defined as "the skill and imagination to develop new things," which highlights its dual nature but only scratches the surface of its significance for business growth and sustainability. Studies have shown that traits like education, income, farm size, cosmopolitanism, membership in farmers' organizations, access to information, and other human factors all favour the adoption of suggested techniques (Rogers and Svenning, 1969; Rogers, 1983). A stepwise multiple regression analysis was done with 27 independent variables with innovativeness score as a dependent variable. The final regression model explained 74.60% of the variation and was significant (P > 0.001). (Table-1)

According to this model, the degree of actual knowledge is a key factor in determining how innovative a farmer is. Having management skills for budgeting, having managerial aptitude, and being more resourceful (in terms of household spending and milk productivity) were all significant predictors of inventiveness. The ability of the farmers to make decisions, their interactions with the local cooperatives, media exposure, contact with extension agents, and cosmopolitanism all had an impact on innovation.

Perception of Stakeholders towards the adoption and popularization of Farmer-led Innovations:

Perceptual attributes of the identified Farmer-led Innovations were measured through 5-point Likert scale. The stakeholders

Table 1: F ratios, standard errors, and regression coefficients of innovativeness on the most crucial factors (Total R = 74.60)

Independent Variables	Co-efficient	Standard Error (SE)	F	Cumulative R
Practical Understanding	0.654	0.231	25.40	38.5
Household expenditure administration	0.004	0.021	7.89	48.5
Managerial Aptitude	0.854	0.679	7.42	52.5
Decision Making Skills	0.472	0.203	7.23	61.3
Co-operative Contact	0.324	0.786	6.87	65.7
Cosmopoliteness	0.657	0.134	5.47	68.7
Maas Media Exposure	0.897	0.067	3.78	70.9
Extension Contact	0.243	0.954	2.98	72.5
Dairy Farming Innovations	0.564	0.654	2.32	74.6

R^2= 0.7460; F = 12.89 (for whole model); P > 0.001

were asked to read the initial 37 items of the scale under four aspects namely Relevancy, Profitability, Sustainability and Adaptability. KMO and Bartlett's test of sphericity was used to confirm that the data were appropriate for factor analysis. The correlation matrix has elements that need to be discovered, as shown by the KMO value of 0.903 for the perception scale. The results of Bartlett's test of sphericity, which were 2 (666) = 9229, p 0.0001, which tells us about their enough co-relation to support the PCA. The results of the two experiments showed that using Principal Component Analysis was adequate. The scree plot generated from PCA recognized 4 components that showed nearly 67.80% of the final scale as compared to the 30.30% of the variation explained in the initial scale. The Monte-Carlo PA software also validated the four components in a parallel analysis. The four components shaped with seven, three, three and two sub-items were also done by Oblique rotation, through a number of iterative process.

The excessive cross- loading of two or more factors resulted in removal of eight items, ten items due to the poor communalities during the extraction process, low factor loading resulted in removal of two items and two items due to the reduction in their cross-relation to other items. Pattern matrix in Table 3 shows the corelation between each item and uncorrelated components that were reinstated by using the iterative process of oblique rotation.

The four aspects of the 15-item scale that were used by PCA were named as relevance, profitability, sustainability, and adaptability in accordance with the fundamental idea expressed by the predominate items. The Cronbach's Alpha accounted for 0.857 for items of the scale measure. The analysis of the inter-item consistency revealed strong internal co-relation; 0.889 for relevancy, 0.750 for profitability, 0.710 for sustainability, and 0.666 for adaptability. On the basis of a meta-analysis, Tornatzky and Klein (1982) identified three innovation characteristics i.e., compatibility, relative advantage, and complexity—as having the strongest, most consistent correlations with innovation adoption. Additionally, Yaacoba and Yusoff (2014) indicated that factors that influence adoption of Farmer-led innovation include compatibility, trialability, outcome demonstrability, image, and visibility.

The content validity of the Perception scale was assured through methodological rigor, which included a review of relevant literature, in-depth interviews with stakeholders, and expert review. By comparing the perception measure with global satisfaction criterion items, concurrent validity was evaluated.

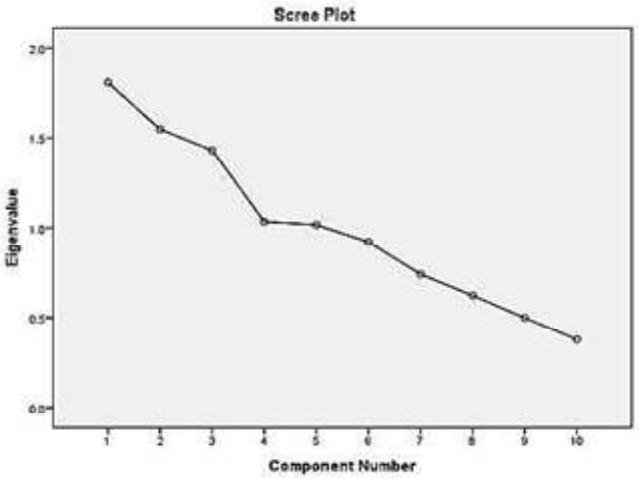

Fig. 1 Scree-plot diagram

The summated perception scale score's Pearson product-moment correlation revealed correlation coefficients of 0.711 (p 0.001) and 0.881 (p 0.001), respectively. By looking at the component's correlation matrix for the rotated end components, construct-related validity was established. As can be seen in the table below, this suggested that there was little connection among the components. We found low Pearson correlation values between the components. The factor stability of the developmental sample was confirmed using principal component analysis on a random split sample; all four factors were retained with little change in factor loading.

In order to enhance the draft tool's content coverage, the items' applicability to specific local contexts in the specified dimensions, and the scale's face and content validity, a group of experts evaluated it. By showing the stability of the four subscales (relevancy, profitability, sustainability, and adaptability) as well as the scale's high internal consistency, factor analysis supported the scale's construct validity. The observed reliability is within DeVellis's, 2003 acceptable internal consistency range. The four components identified were found to be interrelated with low correlation coefficient which stands out to be good evidence for the scales construct validity. The four factors of relevance, profitability, sustainability, and adaptability are those that stakeholders in the research region believe to be most crucial, which is further strengthen by the scale construct validity computed.

Concurrent validity was established by comparing the summated perception tool to two items from the overall satisfaction tool

Table 2: Oblique rotation statistics for factors with Eigen Values greater than 1

Factors	Eigen Value	% of Variance	Cumulative %
1	8.675	37.6	37.6
2	5.432	12.7	50.3
3	2.324	10.7	61.0
4	1.321	6.8	67.8

that were thought to be closely linked to perception. Concurrent validity was demonstrated by the two measures' highly significant correlations (0.711, p 0.001 and 0.881, p 0.001). Due to the substantial association between the perception scale and measures of overall satisfaction, it is clear that stakeholders who are happy with relevancy and profitability of the Farmer-led innovations have favorable attitude towards its adoption. In response to these shifts, there has been an increase in interest in farmer-led innovation. It is now clear from a growing body of literature (Naouri *et al.* 2020; van Dijket *et al.* 2017; Waters-Bayer *et al.* 2015; Macmillan and Benton, 2014; Lowe *et al.* 2019; Tambo and Wünscher, 2017;) that the governmental agencies and different stakeholders which includes the European Commission, 2016 and the UK's Department for Environment, Food, and Rural Affairs, are coming forward in promoting these Farmer-Led Innovations in a wider scale. (Innovative Farmers, 2020).

Four components were loaded with the 15 items from the final perception measure. To the components that were recovered, the qualities of relevance, profitability, sustainability, and adaptability were given. The scale's criterion-related validity was shown by the final perception scale's high correlation with the global satisfaction ratings. The process of creating the item guaranteed the authenticity of the procedure. Low correlation between the components and high average factor loadings of 0.76 to 0.82 supported the construct validity of the perception measure. To verify the scale's stability, a randomly selected split sample of 120 samples from the validation sample was used. With a score of 0.845, the final 15-item measure demonstrated adequate reliability.

The 15-item perception scale based on relevance, profitability, sustainability, and adaptability was discovered to be a legitimate and dependable indicator of how stakeholders view the

Table 3: Pattern matrix Perception scale

S.N.	Statements	Components 1	2	3	4	Communality	Component label
1.	FLI,s helps to enhance farmer's backward and forward linkage with several enterprises.	0.811				0.724	Relevancy
2.	FLI,s helps farmers to empower themselves and their community.	0.792				0.669	
3.	Farmers are not aware of the commercialization process of the FLI,s.	0.789				0.604	
4.	The relative analysis of the costs associated with the innovation was considered.	0.777				0.677	
5.	We must consider refinement and simplification of the innovation for better dissemination.	0.731				0.632	
6.	The potential of the innovation for achieving economies of scale was analysed.	0.724				0.598	
7.	The estimation of the innovations comparative impact and achievement was done.	0.703				0.599	
8.	Ensure proper documentation of the innovation/ intervention.		0.826			0.725	Profitability
9.	The innovations discourse a potential need for the stakeholders in the region.		0.820			0.765	
10.	Less number of people were involved in the adoption of an FLI.		0.781			0.725	
11.	The cost effectiveness of the innovations as compared to the existing solutions were properly established.			0.897		0.743	Sustainability
12.	The innovations proportional effect and accomplishment was established.			0.710		0.587	
13.	Demand and supply were chalked out in impacting a large number of beneficiaries.			0.684		0.666	
14.	FLI,s are implementable within existing systems and infrastructure.				0.840	0.760	Adaptability
15.	FLI,s enhances the societal status of any particular individual				0.820	0.718	

Extraction method: Principal component analysis

Rotation method: Oblimin with Kaiser normalization

beginning and growth of farmer-led innovations in dairying. Farmer-led innovations that were developed for practical problem solution or creative application have aided in efficiently handling agricultural activities and maximizing farm profits (Singh N. *et al.*2018). On the other side, farm innovators might successfully transition into consultants and business owners, opening up options for off-farm income generation. Farmer-led innovations would increase output in developing nations, lowering rural people's levels of poverty (Spielman 2009, Mariam *et al.* 2011). To strengthen the factor structure of the perception scale, additional exploratory and confirmatory factor analysis studies in additional sample areas are required.

Weighted importance of Perceptual attributes of Farmer-Led Innovations as reported:

Table 5 makes it abundantly obvious that the stakeholders place a high priority on comparative cost analyses of innovations, which are then properly documented by all types of internal and external agencies. The stages of scaling up Farmer-led innovations were also highlighted by the World Health Organization (WHO 2010), including scheduling actions, developing capacities, making strategic decisions, and assessing the environment. According to a study by Baliwada *et al.* 2017 scaling up innovations needed commitment and more financial support. They also suggested using a corporate social responsibility fund to involve the private sector in the commercialization of discoveries that are replicable.

The maximum possibilities of achieving economies of scale are also considered for the stakeholders for the effective dissemination of the scale in the different regions. Perceptions of the stakeholders varies from the attributes of cost-effectiveness to the innovations' comparative impact and success. Farmer-led Innovations can also cater a great role in empowering the farming communities and their parallel diffusion

Table 4: Component correlation matrix

Component	Relevancy	Profitability	Sustainability	Adaptability
Relevancy	1.0	0.113	0.356	0.250
Profitability	0.113	1.0	0.019	0.065
Sustainability	0.356	0.019	1.0	"0.009
Adaptability	0.250	0.065	"0.009	1.0

Table 5: Perception Scale statements according to their Weighted Mean Score

Sl. No.	Statements	Weighted Mean Score	Rank
1.	FLI, s help to enhance farmers' backward and forward linkage with several enterprises.	13.79	VIII
2.	FLI, s help farmers to empower themselves and their communities.	14.28	VI
3.	Farmers are not aware of the commercialization process of the FLI, s.	13.76	IX
4.	The relative analysis of the costs associated with the innovation was considered.	16.87	I
5.	We must consider refinement and simplification of the innovation for better dissemination.	12.97	XIII
6.	The potential of the innovation for achieving economies of scale was analyzed.	15.76	III
7.	The estimation of the innovations comparative impact and achievement was done.	13.66	X
8.	Ensure proper documentation of the innovation/ intervention.	15.78	II
9.	The innovations discourse a potential need for the stakeholders in the region.	13.21	XII
10.	FLI requires the involvement of a smaller number of people in the adoption decision.	12.63	XV
11.	The cost effectiveness of the innovations as compared to the existing solutions were properly established.	14.98	IV
12.	The innovations proportional effect and accomplishment was established.	14.65	V
13.	Demand and supply were chalked out in impacting a large number of beneficiaries.	12.89	XIV
14.	FLI, s is implementable within existing systems and infrastructure.	13.97	VII
15.	FLI, s enhances the societal status of any particular individual	13.65	XI

Table 6: Perception level of Stakeholders towards Farmer-led Innovations

S.NO	Level of perception	Frequency	Percentage
1	Low (<0.33)	118	32.78
2	Medium (0.33-0.58)	158	43.89
3	High (>0.58)	84	23.33

amongst the communities. Innovative solutions developed by farmers may be essential for addressing the problem of global food security and eradicating rural poverty (de Janvry and Sadoulet, 2002). Farmers are being urged to use the technological advancements that scientists have been creating and disseminating in field-based innovations more frequently in recent years (Gatzweiler and Von Braun, 2016). Linkages among farmers with the different enterprises can be improved followed by its non-awareness of the commercialization process. Stakeholders also felt the importance of the successful diffusion of Farmer-led innovations into a larger population by giving cognizance to a greater number of people's adoption decisions at the same place. According to several studies (Kummer *et al*. 2012; Tambo and Wünscher, 2017 Reij and Waters-Bayer, 2001;), such farmer-led innovation-generating techniques are critical to tackling food insecurity issues and strengthening community resilience to changing environmental conditions.

Level of perception of Stakeholders towards Farmer-led Innovations:

According to Table 6, 23.33 and 32.78 percent of stakeholders were found to be in the high and low level of perception categories, respectively, while 43.89 percent of the stakeholders fell into the middle level of perception category. This was due to that most of the Farmer-led Innovations were in the incubation stage and around three-five years old. The benefits incurred were not fully utilized in such a short-run period rather they understand it will be beneficial in the long run. The perception-altering effects of these farmer-led innovations show a growing understanding of the significance and value of locally based farming innovations, which support current policies for rural development and poverty reduction while also challenging the traditional technology strategy (Tran *et al*.2019). The agricultural ecosystem needs innovations to achieve food security and end rural poverty (Leitgeb *et al.* 2011; Brooks and Loevinsohn, 2011). To achieve economies of scale, farmer-led innovations should be sustained for a long time in the field.

Conclusions

Farmer-led innovations must have the most advantageous features possible to draw in prospective users. The innovations' relative edge over the technology it will replace, compatibility with local cultures, and observability are what attract farmers to them most. Simple, practicable, and compatible with the context of farmers and their agricultural circumstances, needs, and experiences are requirements for any innovation or technology. According to the findings of the current study, each institution working on farmer-led innovations is operating separately, in isolation, with their own resources, and according to a plan of activities that has a very small effect. As a result, institutions focusing on farmer-led innovations should network at the national level. Demonstrating the favourable and statistically significant welfare benefits of farmer-led innovations, the findings support farmers' views as well as the numerous anecdotal accounts of farmer-led innovations' substantial contribution to the livelihoods of rural farm households. A model for scaling up farmer-led innovations in India has been suggested based on the research results of the current study. The consequences for policy-level decisions should be taken into account as this needs to be improved and validated by various experts.

Acknowledgments

For their timely assistance and cooperation during the research work, the authors are thankful to the Director and Scientists of National Dairy Research Institute in Karnal, India.

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