'Pusa Samachar': an innovative multimedia-based extension advisory model

R. Roy Burman, Girijesh Singh Mahra*, A. K. Singh, Sonali Mallick, Anjali Anand, Ananta Vashisth, Gyan Mishra, Kapila Shekhawat, Vishal Somvanshi, Shalini Gaur Rudra, Seema Sangwan, Bipin Kumar and Ajit K. Das

ICAR-Indian Agricultural Research Institute, New Delhi 110 012, India

Access, efficiency and affordability of agricultural information are a prerequisite for achieving set targets of agricultural productivity. Information and communication technology (ICT) equipped with social media reach can play a leading role in disseminating correct information to needful farmers at the right time. The ICAR-Indian Agricultural Research Institute in-house initiative 'Pusa Samachar' is an innovative multimedia-based extension advisory model that targets to reach farmers across India with timely, location-specific and customized farm information. The present study was conducted to get an overall idea about the viewership pattern and to validate this model under content, design, ease of understanding and fulfilment of information needs. Analysis of secondary data from YouTube analytics and primary data collected from different stakeholders has shown that with changes in the format, style and presentation of the content, the trend of viewing changed and therefore four episodes performed better than the others with respect to the number of views, watch hours and subscribers added per episode. The findings also indicate that the number of views depend on the episode duration ($\chi^2 = 83.049$, $P = 0.001264$); however, the average view duration per episode is independent of episode duration ($\chi^2 = 3.1821$, $P = 1$). Overall, the present study has shown how initiatives like Pusa Samachar have immense potential to reach farmers across the nation through social media. Such initiatives can be taken up by other public institutions as reliability and validity of their content is high. However, the results have shown that diversification with respect to content and audio-visuals is further needed to attract and retain more audience.

Keywords: Farmers, Information and Communication Technology, multimedia-based extension, social media.

INFORMATION is considered one of the most valuable resources in agricultural and rural development programmes[1,2], and an important input in agriculture[3]. When engaged in farming activities, farmers need different types of information at each stage of the development process, from the weather forecast, input management, farming practices[4–6], pest and disease management[7], and market information and prices[8]. In the complex decision-making process during farm operations, farmers are exposed to various kinds of innovative information, and must select the one that best fits their farm with risk minimization and profit maximization[9–11]. Depending on the nature of the information required, farmers use their preferred sources like fellow farmers, progressive farmers, television, radio, newspapers, private agents and mobile phones[12–14]. Information-seeking behaviour of individuals varies according to the complexity of the task[15], time of operation, location[16] and availability of information sources[17].

Current agricultural extension approaches in India face many difficulties in delivering timely, reliable and relevant information to farmers[18]. Public extension system responsible for disseminating agricultural information to farmers has become less efficient, more time-consuming and does not meet their requirements[19]. Today, information and communication technology (ICT) is vital in delivering responsive agricultural extension services to farmers. Many organizations use modern information technology in India to promote communication between researchers, extension agents and their farmer clients to transfer technology and information more effectively[20–22]. Mobile phones were first adopted mostly by wealthier, urban and more educated citizens, but in recent years, they have been adopted by a wider range of people in some of the world's poorest rural and urban communities. In developing countries, rapidly expanding mobile telephony has unveiled a new search technology that includes a number of features and advantages over other options in terms of cost and location coverage as well as ease of usage and to potentially improve farmers' access to information through the involvement as members of the social media network as sources[23,24]. Benefits of weather and market information delivered through SMS on mobile phones have little effect because in push messages farmers are only receivers and they often find it difficult to communicate problems in their own language; thus videos might be helpful in properly presenting the issues to them[25]. The digital green video communication system

*For correspondence. (e-mail: girijeshmahra22@gmail.com)

in India combines technology with social organizations to increase the cost-effectiveness of existing agricultural extension[26].

With the advent of smart technology, the total number of internet subscribers in India has reached 825.30 million, with 322.77 million rural internet subscribers[27]. Increase of internet subscribers in both rural and urban India has led to more active social media users due to its unique experience and special features of openness, connectedness, participation and conversation[28]. While many farmers around the world use social media to connect with their experts and fellow farmers, extension workers and extension organizations are reluctant to stereotype farmers and consider them not to be tech savvy[29,30]. Social media is still a novel idea to many, but slowly people are realizing that it is worth investing time in social media to remain updated, and socially and professionally relevant[31]. Digital technology can give a special edge to extension[32] and social media can be a useful tool for both farmers and extension workers in this regard. Facebook has about 410 million active users in India, Twitter 17.5 million users, WhatsApp 530 million users and YouTube has more than 448 million users as the leading social media networks[33]. As more farmers are using social media networks around the world and have found them to be effective on their farms[34,35], these can be used by extension agents as well, but content and reach must be decided based on the users[36,37]. YouTube search with keywords 'agriculture' gives about 300,000 hits and 'agriculture' about 889,000 hits, while 'farming' gives 10,400 hits[38]. Multimedia is a combination of graphics, video, sound, animation and text; it can provide better information than any of these can alone. There is a common belief that 'more is more' and 'the sum is greater than the parts'[39]. Although personal use is common, professional use of social media by extension staff at the individual or organizational level to disseminate information is rare, mainly due to a lack of awareness[40].

A growing corpus of research shows how social media, as a frequent and intense element of everyday life, has become one of the key vehicles through which people can express themselves[41]. Social media offers various affordances compared to earlier types of representation and communication technology; viz. visibility (allowing people to make their knowledge, preferences and behaviours visible where it was previously difficult to see); persistence (allowing the communication to remain visible after its author has first presented it); editability (allowing people to craft and redraft purposeful forms of communication) and association (allowing people to attach their communication to other people or a piece of information through tagging)[42]. While social media has a lot of potential in this area, there are several limitations in terms of data availability and its greater representation of the farming population. On the other hand, studies have examined how social media may be utilized to promote commodities and showcase new technology and innovation[43]. It must be used to complement and supplement more traditional means of information sharing in agricultural marketing, education and extension[44].

Conceptual framework

Several organizations in India are making substantial use of current information technology to improve communication between researchers, extension workers and their farmer clients to transfer technology and knowledge cost-effectively and more efficiently. Even in agriculture, social media, which was traditionally mostly used for entertainment, has enormous potential for information exchange and collaboration. According to GFRAS (2015) survey on 60 countries, 95% of respondents agreed that social media could help bridge the gap between stakeholders in agricultural innovation systems. Mobile-based technology, especially social media, can provide content in vernacular language, which can be achieved by strengthening existing technologies by local language-based content development, and ultimately the services can be applicable to farmers[45]. It is vital to ensure that adequate material is available for farmers in a language they can comprehend and in an appropriate format so that ICT applications can boost their production[46]. Multimedia-based advisory services deliver information through different technologies, but the access and usage of these technologies differ; so research should focus on the information effect disentangling from technology effect. Information delivery should focus not only on knowledge gain and sharing, but also on productivity and increase in income level, and focusing on timelines and relevance of the information. As a result, in order to achieve effective ICT-led information delivery, strategies must be developed by examining the digital environment of the location where key players are involved in the design and implementation of the programmes[47]. With these above considerations, ICAR-Indian Agricultural Research Institute (IARI), New Delhi, developed a multimedia-based extension model named 'Pusa Samachar' for two-way information sharing through social media. Under this model, timely, location-specific and need-based information on major crops along with weather information was given to farmers across India through YouTube. Pusa Samachar was launched on 15 August 2020 and the first episode was uploaded on 22 August 2020. Since then, every Saturday at 7 pm, a new episode is uploaded on the official YouTube channel of IARI. Till now, 88 episodes in Hindi have been uploaded. In view of reaching more farmers across the nation, Pusa Samachar is also being developed in five regional languages, under which 14 episodes in Telugu, 26 in Kannada, 22 in Tamil, 25 in Bangla and two episodes in Oriya have been uploaded. The number of subscribers is growing by the day and it has already reached around 22,000 with 610,234 views. Every episode includes time-specific crop management practices, successful farmer

stories, Pusa WhatsApp salah and weather broadcasts. A dedicated Pusa WhatsApp number has been launched to which farmers send their farming-related problems with photographs and scientists reply promptly. Each Pusa Samachar YouTube episode includes a selection of issues and their scientific solutions.

Materials and method

Study area, sampling, data collection

Secondary data from YouTube analytics have been collected in order to get an overall idea about the viewership pattern. To validate the content of this model, primary data were collected from different stakeholders, which included 159 farmers, 112 students, 25 researchers and 22 extension professionals. Thus, primary data were collected from 318 respondents in addition to the data of YouTube analytics.

Content analysis of Pusa Samachar model

In day-to-day farming, farmers need information regarding best-quality seeds, their availability, pest and disease management, marketing, etc. so they can enhance their income by adopting improved farming practices. To analyse the coverage of content of Pusa Samachar, a content analysis of 49 Hindi episodes was conducted. The subject matter has been categorized as agronomy, genetics, plant pathology, vegetable sciences, horticulture, entomology, agricultural engineering, microbiology, soil sciences and success stories of farmers.

Viewership and subscriber-joining pattern

With the addition of new episodes every week and changes in the modelling of content development, the total number of subscribers and viewing hours have increased. Although there is an increase in total subscribers, we must analyse the pattern of the number of views per episode. Episodes are then classified into low, medium and high according to the number of views per episode using mean and standard deviation. The pattern of subscribers added per episode has also been analysed and classified as low, medium and high using mean and standard deviation. Watch time (h) to the number of subscribers added has been correlated using Pearson's correlation. Pearson's chi-squared test was used to check the level of dependence, if any between duration and views of each episode. The relation between episode duration and the number of views was analysed for further content development with the management of time duration. Level of dependence, between average view duration and duration of each episode was also checked using Pearson's chi-squared test.

Validation of the model

Further validation of the model was done by analysing the stakeholders' perception with respect to its effectiveness along with viewing and sharing behaviour by collecting primary data from both primary (farmers) and secondary (students, researchers and extension professionals) stakeholders. Preliminary data were collected on the regularity of watching the channel, subscriber membership, sharing behaviour with colleagues, source of information about the model from YouTube, WhatsApp, Facebook, Twitter, watching frequency – weekly, fortnightly or monthly, and watching the pattern of episodes. Validation of the model was done by the stakeholders under three broad criteria as content and design, ease of understanding and fulfillment of information needs. Systematic presentation of content, appropriateness for learning experience, audibility of episodes, readability of text, average time duration of a full episode and average watch time of each crop segment has been covered under the criteria for validation of content and design. The model was also validated under the criteria of ease of understanding, comprehensible style of presentation, comprehensible scientific content, language used by anchors, ease of understanding the scientific inputs of experts and relevancy of the content in today's farming, and self-explanatory graphics with respect to crops/varieties/diseases/pests. The model was validated with respect to the fulfillment of information needs of stakeholders under six heads: usefulness of information, providing updated information, ability to cater the information need, ability to save time and money and practical applicability in stakeholders day-to-day life. Further, Pusa WhatsApp salah has also been added under this criterion. For validation of the model, stakeholders responded on a five-point Likert scale from strongly agree to strongly disagree. Under data analysis, weighted mean score (WMS) of each criterion was calculated for the dataset of stakeholders' response using standard formula of weighted mean score

$$\text{Weighted mean} = \sum wx / \sum w,$$

where w is the weight and x is the value.

Results

Content analysis of the model

Content of multimedia-based agricultural advisory services plays a major role in delivering information according to the needs of the stakeholders. From the content analysis of the Pusa Samachar model in Hindi, it was reported that a total of 128 topics were covered in 17 different disciplines/areas, including success stories of farmers. Analysis has shown that among disciplines, the topic coverage was maximum under vegetable sciences (21%), followed by

agronomy (17%), genetics (13%), success stories of farmers (10%), plant pathology (9%), entomology (6%), horticulture (5%) and microbiology (5%). Topics from other disciplines had a coverage of 14%, which included those from protected cultivation, agricultural engineering, soil science, economics, floriculture, student-based topics/careers, biochemistry, agricultural chemicals and extension. Figure 1 shows the content analysis of 49 episodes of the Pusa Samachar model.

If we consider crop-wise, the coverage is 25 topics on cereals (rice, wheat, maize, millets), five on oilseeds (mustard), 25 on vegetables (leafy vegetables, peas, onion, garlic, carrot, tomato, potato, bathua, okra, bitter gourd, bottle gourd, cucumber, chilli, general management), seven on pulses (chikpea, lentil, mungbean), 7 on fruits (papaya, guava, mango, apple, citrus), two on floriculture (rose and protected cultivation) and 31 on general topics (integrated farming system, soil-less cultivation, leaf colour chart, Pusa decomposer, farm bills, career in agriculture, Pusa STFR meter, biofertilizers application, spirulina, mushroom production, etc.)

Numbers of views

Episodes were classified as low, medium and high on the basis of the mean and standard deviation with respect to views over time. It is evident from Figure 2 that six episodes (number 1, 4, 12, 23, 28 and 29) were under high category with more than 4625 views in each and five episodes (number: 35, 36, 37, 38 and 39) were under low category with less than 2157 views in each. The rest of the 38 episodes were under medium category with views between 2157 and 4625.

Watch hours

The data with respect to watch hours and number of views were analysed after collection from YouTube analytics. The episodes were categorized into low, medium and high on the basis of mean and standard deviation with respect to watch time (hours). It is evident from Figure 2 that six episodes (number: 1, 12, 23, 28, 29 and 30) were under high category with more than 254 watch hours in each episode and seven episodes (number: 36, 37, 38, 39, 40, 44 and 49) were under low category with less than 130 watch hours in each episode. The remaining 37 episodes were under medium category with views between 130 and 254.

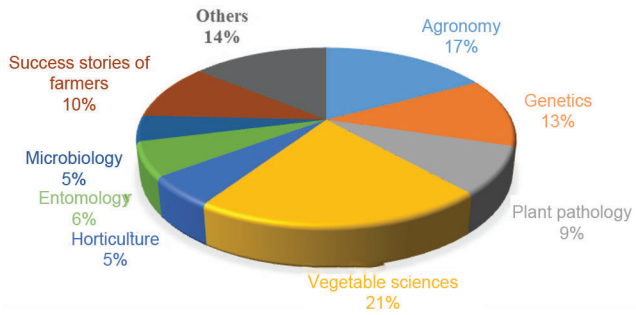

Figure 1. Pie chart showing content analysis of the Pusa Samachar model.

Subscribers added by each episode

The episodes were further categorized into low, medium and high categories on the basis of mean and standard deviation with respect to subscribers added by each episode. It is evident from Figure 3 that six episodes (number: 1, 2, 3, 4, 23 and 25) were under high category with more than 347 subscribers added in each and nine episodes (number: 32, 33, 36, 37, 38, 39, 40, 43 and 49) were under low category with less than 81 subscribers added in each. Rest of the 34 episodes were under medium category, with subscribers added between 81 and 347.

Data with respect to watch time hours of 49 episodes were correlated with the number of subscribers added by each episode. It had a positive correlation with a correlation coefficient of 0.801. Thus it is evident from Figure 3 that with an increase in watch time (h) there is an increase in number of subscribers added per episode. It was found that the duration of each episode plays a role in the viewing pattern of subscribers (Figure 4). Pearson's chi-squared test was conducted to check the dependence of the number of views and episode time duration in each episode. For this purpose, a null hypothesis was set, that is 'Episode views are independent of its time duration'. It was found that the number of views was dependent on episode duration (χ^2 = 83.049, P = 0.001264, df = 48, null hypothesis rejected). Pearson's chi-squared test was executed again to check the dependence of average view duration and time duration in each episode. The null hypothesis set was 'The average view duration is independent of its time duration'. It was found that the average view duration was independent of episode duration (χ^2 = 3.1821, P = 1, df = 48, null hypothesis accepted).

Perception of stakeholders with respect to this model

The data with respect to perception of stakeholders was collected with the help of pretested questionnaire. It was found that 88.67% of primary stakeholders (farmers, n = 159) regularly watched Pusa Samachar and 81.13% of them shared this content with their colleagues. YouTube was the major source of information (67%), followed by WhatsApp (15%), verbal communication with colleagues (13%), Facebook (4%) and Twitter (1%). It is evident from Table 1 that for primary stakeholders, YouTube played the most important role, while Twitter was the least preferred source of information about the multimedia-based extension advisory model. With respect to the watching pattern

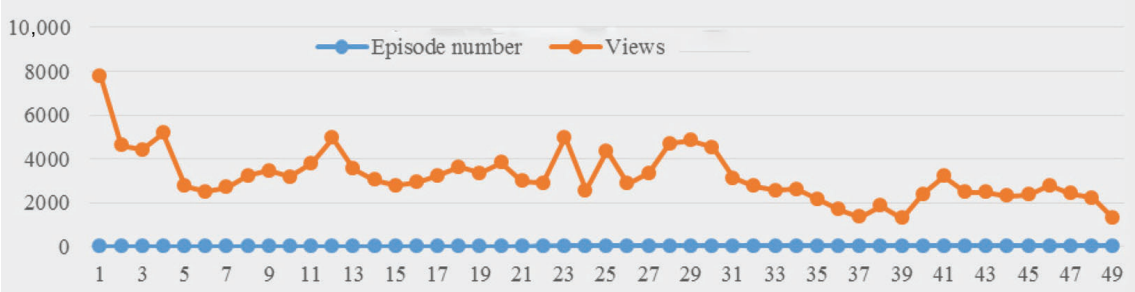

Figure 2. Trend of number of views over time of the Pusa Samachar model.

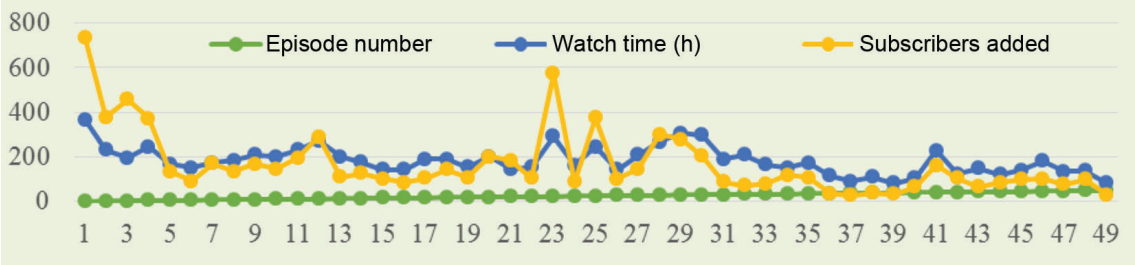

Figure 3. Watch time (h) and subscribers added by each episode.

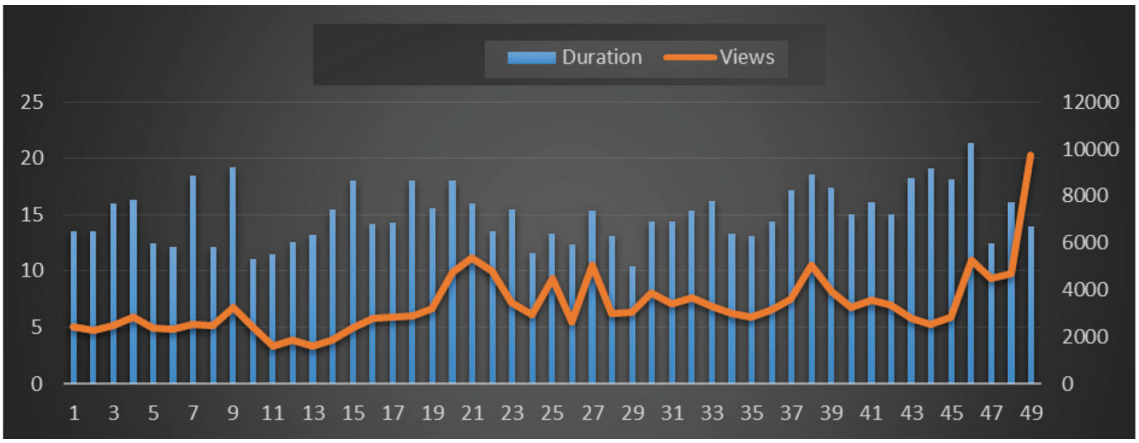

Figure 4. Episode duration and views of the Pusa Samachar model.

of stakeholders, it was found that 83% of stakeholders watched Pusa Samachar weekly. On further analysis, it was found that 67% preferred to watch the whole content, while 32.7% preferred to watch the portion of the content which was relevant to them, rather than watching the whole content developed (Table 2).

Perception of stakeholders with respect to the model was captured under three heads: content and design, ease of understanding and fulfilment of information needs. It is evident from Table 3 that the majority of stakeholders considered content creation to be systematic and helped in better learning. They mentioned that the video text was clearly readable, but the sound and video quality needed improvement. Table 3 also reveals that majority of stakeholders considered that the average time duration of each crop segment within each episode was optimum, however, the average time duration of a full episode needed improvement with respect to time duration. Thus, the focus was needed on audio and video quality and time duration for developing better quality content. From the prospect of understanding, the ranking of stakeholders indicates that the style of presentation, scientific content and language are comprehensible; however relevant content with respect to current farming practices and graphics used in the videos need improvement for better understanding on the part of viewers. In meeting the information demands of stakeholders, this platform provides relevant, valid and up-to-date information, saving viewers' time and money as a medium for learning new technologies. The informal platform WhatsApp salah catering to customized problems

Table 1. Source of information of stakeholders (n = 318)

Profession		Source of information (%)				
		YouTube	WhatsApp	Facebook	Twitter	Fellow colleagues
Primary stakeholder	Farmer	70.44	17.61	2.51	0.6	8.80
Secondary stakeholder	Student	69.64	7.14	4.46	1.78	16.96
	Researcher	56.00	20.00	4.00	–	20.00
	Extension professional	40.90	31.81	13.63	–	13.63
Total	318	66.9	15.09	4.08	0.9	12.89

Table 2. Frequency of watching and viewing pattern of stakeholders

Profession		Frequency of watching (%)			Viewing pattern (%)	
		Weekly	Fortnightly	Monthly	Full episode	Relevant portion
Primary stakeholder	Farmer	89.30	4.40	6.28	76.72	23.27
Secondary stakeholder	Student	73.21	9.82	16.96	52.67	47.32
	Researcher	88.00	8.00	4.00	60.00	40.00
	Extension professional	77.27	18.18	4.54	81.81	18.18

needs to be strengthened by converting it into an automated query redressal system for the stakeholders.

Discussion

The results of this study show some interesting facts with respect to the number of views, watch hours and subscribers added per episode. There are six episodes under each analysis unit; number of views, watch hours and subscribers added per episode which fall under high category. These are the episodes, where innovations with respect to presentation have been done, which has increased the number of views, watch hours and subscription base. For instance, in the fourth episode, two anchors were introduced on screen for the first time and also the anchors were changed after completion of one scientific topic within that episode; in the 12th episode, changes were made in text colour and font in the content; in the 23rd episode success stories of farmers and weather reports were included for the first time and in 29th episode information about newly released rice variety. Pusa Basmati 1692 was given along with the success story of the innovative farmer awardee. So, with changes in the format, style and presentation of the content, trend of views changed and therefore these four episodes were under high category with respect to the number of views, watch hours and subscribers added per episode. Most of the earlier studies also supported that signalling, i.e. cueing as addition of keywords, change in colour or addition of symbol helps to retain attention of viewers by helping them to process the information in proper time[48–50]. It is interesting to note that for episodes in which the number of views had increased, there was an increase in the number of subscribers also, which signals that diversification of content with respect to style of presentation leads to acceptance of the viewers to the model.

The analysis of audience engagement and episode duration showed that the views dependent on the overall episode duration. According to several research studies, the optimum duration of educational videos for YouTube content should be 6 min. Thus it is suggested that content creators should focus on creation of videos in short chunks[51], while this is not followed in case of technical content for learning new technologies and improving outcomes. The present study has also shown that duration of an episode is independent of the average watch duration, which clearly indicates that the content and way of presentation are more important than duration of episodes. Stakeholders may watch a single long video over several viewing sessions, resulting in a low average watch time having watched the entire video. Stakeholders can also return to a long video numerous times to watch only a portion of it for a few crop segments or management practices. An analysis of average viewing time revealed that despite the disparities in involvement, both video formats were viewed in the same time duration in the same way. Short videos could be suitable for learning a new technique, as a stand-in for a method demonstration, or as a source of pertinent weather information or disease and pest management. Longer duration films, on the other hand, are essential in learning a complete package of practice, such as new crop practice or new technology adoption. The best video length is determined by the interaction of multiple factors[52].

Vlogs or video blogs on the internet are becoming increasingly popular as a kind of media content[53]. Regular subscribers of IARI official channels get notifications of newly uploaded episodes of Pusa Samachar. In addition, IARI also uploads content information with respect to Pusa Samachar on Facebook, Twitter and WhatsApp. It was found that 67% of stakeholders got information about Pusa Samachar's newly uploaded episodes from YouTube, followed by Facebook (19%), WhatsApp (11%) and Twitter

Table 3. Perception of stakeholders with respect to Pusa Samachar: weighted mean square (WMS) and rank

	WMS	Rank
Content and design		
Content has been presented systematically	4.481	I
Content is appropriate for learning experience	4.453	II
Sound of episodes is audible and clear	3.776	VII
Videos in episodes have good clarity	4.434	IV
Text is clearly readable	4.440	III
Average time duration of full episode is optimum	3.951	VI
Average time duration of each crop segment within episode is optimum	4.284	V
Ease of understanding		
Style of presentation is easily comprehensible	4.487	II
Scientific content is clearly comprehensible	4.478	III
Language used by anchors and experts is understandable	4.528	I
Content has relevance in today's farming	4.443	IV
Graphics with respect to crops/varieties/diseases/pests, etc. is self-explanatory	3.715	V
Fulfilment of information needs		
Overall information is useful for farmers	4.554	I
The given information is valid and updated	4.465	II
Content caters to my information needs (according to cropping season)	4.377	III
Pusa Samachar saves my time and money	4.292	VI
I have learnt new farming technologies through Pusa Samachar	4.345	IV
I am practising what I am learning through Pusa Samachar	3.995	VII
Pusa WhatsApp salah is helpful in problem-solving	4.330	V

(3%). This clearly indicates that YouTube users utilize the platform for entertainment as well as knowledge[54]. People's access to scientific information has changed as a result of platforms like YouTube[55]. Under the present study, content validation by stakeholders has given directions for further improvements in content and way of presentation of Pusa Samachar episodes, with special reference to audio, video and graphics quality. The audio-visual quality is heavily influenced by audio quality. Even if the video quality is excellent, poor audio quality can diminish the audio-visual experience significantly. An excellent audio quality, on the other hand, can slightly improve the audio-visual quality of a bad video[56]. Thus, there is a need of a fair balance between audio and video quality of content. The level of trust a farmer has in the information will influence how it is used in the field[57] and the potential of ICT in agriculture, which has been underutilized[58]. The results have shown that, this in-house new initiative of IARI has immense potential to reach farmers across the nation through social media. Though the reliability and validity of the content among farmers are high, the results have shown that diversification with respect to content and audio-visuals are needed to attract and retain more audience.

Conclusion

The present study analysed the performance of the multimedia-based agro-advisory model among different stakeholders (farmers, researchers, extension professionals and students). It is clearly evident that content development which is tailor-made and properly designed based on the needs of stakeholders can lead to its acceptance. The study reveals that the duration of content does not affect the watch time of audience, as farmers require information for technical problems which need detailed advisory. The present model has shown that research institutions can effectively act as a knowledge hub for scientific content development and dissemination by harnessing the power of social media. Due consideration should be given to audio, video and graphics management in multimedia for large-scale acceptance. Findings from this study show that different ICAR institutions can deliver multimedia advisory services as ICAR has regional and crop-specific institutions in different areas, and thus tailor-made advisory services can help farmers of every region. State Departments of Agriculture can focus on developing specific multimedia-based crop-based information with regard to variety, disease and pest management with special reference to contingency crop management during crop failure that can perform better compared to the only audio-based advisory of extension professionals.

1. Meyer, H. W. J. and Boon, J. A., Provision of agricultural information for development: a case study on crossing communication boundaries. *Libri*, 2003, **53**, 174–178.
2. Morrow, K., Nielsen, F. and Wettasinha, C., Changing information flows. *LEISA*, 2002, **18**(2), 4–5.
3. Tripp, R., Labour, information and agricultural technology. In *Self-Sufficient Agriculture: Labour and Knowledge in Small-Scale Farming*, Routledge, 2006, pp. 53–55.

4. Jenny, C. A., Dial A for agriculture: a review of information and communication technologies for agricultural extension in developing countries. CGD Working Paper 269, Center for Global Development, Washington, DC, USA, 2011.
5. Nilusha, K., Sriganesh, L. and Ranjula, S. P., Improving farmer services by understanding their information needs, 2011; http://www.cprsouth.org/wp-content/uploads/2011/08/Policybrief_final-V3.pdf (accessed on April 2022).
6. Mittal, S., Modern ICT for agricultural development and risk management in smallholder agriculture in India. International Maize and Wheat Improvement Center (CIMMYT), Mexico, 2012.
7. Cole, S. A. and Fernando, A. N., The value of advice: evidence from mobile phone based agricultural extension, Working Paper No. 13–047, Harvard Business School, Boston, MA, USA, 2012.
8. Ogutu, S. O., Okello, J. J. and Otieno, D. J., Impact of information and communication technology-based market information services on smallholder farm input use and productivity: the case of Kenya. *World Dev.*, 2014, **64**, 311–321.
9. Assael, H., Consumer Behavior and Marketing Action, South-Western College Publication, Cincinnati, Ohio, USA, 1998.
10. Kaine, G., Consumer behaviour as a theory of innovation adoption in agriculture. Social Research Working Paper, AgResearch Ltd, 2004.
11. Hill, M., Using farmer's information seeking behaviour to inform the design of extension. *Extens. Farm. Syst. J.*, 2009, **5**(2), 121–126.
12. Meitei, L. S. and Devi, T., Farmers information needs in rural Manipur: an assessment. *Ann. Lib. Infor. Stud.*, 2009, **56**, 35–40.
13. Mwombe, S. O., Mugivane, F. I., Adolwa, I. S. and Nderitu, J. H., Evaluation of information and communication technology utilization by small holder banana farmers in Gatanga District, Kenya. *J. Agric. Educ. Exten.*, 2014, **20**(2), 247–261.
14. Nikam, V., Kumar, S., Kingsly, I. M. and Roy, M., Farmers mobile use pattern, information sources and perception about mobile app for grapes. *Indian J. Exten. Educ.*, 2020, **56**(1), 77–83.
15. Bystrom, K. and Jarvelin, K., Task complexity affects information seeking and use. *Inf. Proc. Manage.*, 1995, **31**(2), 191–213.
16. Nyambo, B. and Ligate, E., Smallholder information sources and communication pathways for cashew production and marketing in Tanzania: an ex-post study in Tandahimba and Lindi rural districts, Southern Tanzania. *J. Agric. Educ. Exten.*, 2013, **19**(1), 73–92.
17. Solano, C., León, H., Pérez, E. and Herrero, M., The role of personal information sources on the decision-making process of Costa Rican dairy farmers. *Agric. Syst.*, 2003, **76**(1), 3–18.
18. Claire, J., Glendenning, S. B. and Kwadwo, A., Review of agricultural extension in India, Are farmers' information needs being met? International Food Policy Research Institute, Discussion Paper 01048, Washington DC, USA, 2010.
19. Mruthunjaya and Adhiguru, A., ICT for livelihood security: a reality check. *Mainstreaming ICTs*, 2005, **II**(2), 14–18.
20. Saravanan, R., *ICTs for Agricultural Extension: Global Experiments, Innovations and Experiences*, New India Publishing Agency, New Delhi, 2010, pp. 115–168.
21. Kameswari, V. L. V., ICTs for agricultural extension: a study in the Indian Himalayan Region. *Electron. J. Inf. Syst. Dev. Ctries*, 2011, **48**(3), 1–12.
22. Nikulsinh, M. C., Farmers' perception about ICT application: a case study of Gujarat state. *Indian Res. J. Exten. Educ.*, 2010, **10**(3), 21–26.
23. Aker, J. C. and Mbiti, I. M., Mobile phones and economic development in Africa. *J. Econ. Perspect.*, 2010, **24**(3), 207–232.
24. Baye, M., Morgan, J. and Scholten, P., Information, search and price dispersion. In *Handbook on Economics and Information Systems* (ed. Hendershott, T.), Elsevier Press, Amsterdam, The Netherlands, 2006.
25. Fafchamps, M. and Minten, B., Impact of SMS-based agricultural information on Indian farmers. *World Bank Econ. Rev.*, 2012, **26**, 383–414.
26. Digital Green Annual Report 2010–11, Digital Green, New Delhi, 2011.
27. TRAI, The Indian Telecom Services Performance Indicator, Telecom Regulatory Authority of India, Government of India, 2021.
28. Mayfield, A., What is social media? iCrossing, 2008; www.icrossing.co.uk/.../What_is_Social_Media_iCrossing_ebook.pdf (accessed on April 2022).
29. Diem, K. G., Hino, J., Martin, D. and Meisenbach, T., Is extension ready to adopt technology for delivering programs and reaching new audiences? *J. Exten.*, 2011, **49**(6), 172.
30. Payn-Knoper, M., No more food fights! Growing a productive farm and food conversation, Dog Ear Publishing, Indianapolis, USA, 2013.
31. Chander, M., Personal opinion on social media in agricultural extension and advisory services. Global Survey on Social Media for Agricultural Extension and Advisory Services, Global Forum for Rural Advisory Services (GFRAS) Interest Group for ICT (ICT4RAS). GFRAS, Lindau, Switzerland, 2015.
32. Woods, K. and Langcuster, J. C., The use of digital technology in extension. *J. Exten.*, 2015, **52**(5), Article 5COM3.
33. www.statista.com (accessed on April 2022).
34. LeBoeuf, J., De Schutter, A., DeKlein, K., Hamilton, R., Dupuis, T. and Trueman, C., Exploring social media and smartphone ise in ontario agriculture, 2012; http://onvegetables.files.wordpress.com/2012/07/highlights2.pdf (accessed on April 2022).
35. Fahy, B., Agencies' rural research blasts a few stereotypes out of the water. StopPress, 2013; http://www.stoppress.co.nz/blog/2013/03/agencies-rural-researchblasts-few (accessed on April 2022).
36. Kinsley, J., Five social media tools for the extension toolbox. *J. Exten.*, 2010, **48**(5), article number 5TOT7.
37. Gharis, L. W., Bardon, R. E., Evans, J. L., Hubbard, W. G. and Taylor, E., Expanding the reach of extension through social media. *J. Exten.*, 2014, **52**(3), 1–11.
38. Suchiradipta, B. and Saravanan, R., Social media: shaping the future of agricultural extension and advisory services, GFRAS interest group on ICT4RAS discussion paper, GFRAS, Lindau, Switzerland, 2016.
39. Lopuck, L., *Designing Multimedia: A Visual Guide to Multimedia and Online Graphic Design*, Addison Wesley Publications, USA, 1996, p. 160.
40. Rhoades, E. and Aue, K., Social agriculture: adoption of social media by agricultural editors and broadcasters. In Paper presented at the Southern Association of Agricultural Scientists, Orlando, Florida, USA, 2010.
41. DeVito, M. A., Birnholtz, J. and Hancock, J. T., Platforms, people, and perception. In Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing, Portland, United States, 2017, pp. 740–754.
42. Treem, J. W. and Leonardi, P. M., Social media use in organizations: exploring the affordances of visibility, editability, persistence, and association. *Ann. Int. Commun. Assoc.*, 2013, **36**, 143–189.
43. Zipper, S. C., Agricultural research using social media data. *Agron. J.*, 2018, **110**, 349–358.
44. Kaushik, P., Chowdhury, A., Hambly Odame, H. and van Paassen, A., Social media for enhancing stakeholders' innovation networks in Ontario. *Can. J. Agric. Food Inf.*, 2018, **19**, 331–353.
45. Indian Council of Food and Agriculture, ICT in Agriculture, National Round Table Conference, New Delhi, 2017.
46. World Bank, ICT in Agriculture (updated edition): connecting smallholders to knowledge, networks, and institutions, 2017.
47. Upadhyaya, L., Roy Burman, R., Sangeetha, V., Lenin, V., Sharma, J. P. and Dash, S., Digital inclusion: strategies to bridge digital divide in farming community. *J. Agric. Sci. Technol.*, 2019, **21**(5), 1079–1089.
48. De Koning, B. B., Tabbers, H. K., Rikers, R. M. and Paas, F., Towards a framework for attention cueing in instructional animations: guidelines for research and design. *Educ. Psychol. Rev.*, 2009, **21**(2), 113–140.

49. Ibrahim, M., Antonenko, P. D., Greenwood, C. M. and Wheeler, D., Effects of segmenting, signalling, and weeding on learning from educational video. *Learn., Media Technol.*, 2012, **37**(3), 220–235.
50. Mayer, R. E. and Johnson, C. I., Revising the redundancy principle in multimedia learning. *J. Educ. Psychol.*, 2008, **100**(2), 380–386.
51. Guo, P. J., Kim, J. and Rubin, R., How video production affects student engagement: an empirical study of MOOC videos. In Proceedings of the First ACM Conference on Learning@scale Conference, Atlanta, Georgia, USA, 2014, pp. 41–50.
52. Yee, A., Padovano, W. M., Fox, I. K., Hill, E. J., Rowe, A. G., Brunt, L. M. and Mackinnon, S. E., Video-based learning in surgery: establishing surgeon engagement and utilization of variable-duration videos. *Ann. Surg.*, 2020, **272**(6), 1012–1019.
53. Stein, J.-P., Koban, K., Joos, S. and Ohler, P., Worth the effort? Comparing different YouTube vlog production styles in terms of viewers' identification, parasocial response, immersion, and enjoyment. Psychology of Aesthetics, Creativity and the Arts, 2020; https://doi.org/10.1037/aca0000374.
54. Shao, G., Understanding the appeal of user-generated media: a uses and gratification perspective. *Internet Res.*, 2009, **19**(1), 7–25.
55. Huang, T. and Grant, W. J., A good story well told: storytelling components that impact science video popularity on YouTube. *Front. Commun.*, 2020, **5**(1), 86.
56. Sidaty, N. O., Larabi, M. C. and Saadane, A., Influence of video resolution, viewing device and audio quality on perceived multimedia quality for steaming applications. *Internet Res.*, 2014, **19**(1), 7–25.
57. Sseguya, H., Mazur, R., Abbott, E. and Matsiko, F., Information and communication for rural innovation and development: context, quality and priorities in Southeast Uganda. *J. Agric. Educ. Exten.*, 2012, **18**(1), 55–70.
58. Sulaiman, R. and Holt, G., Extension, poverty and vulnerability in India: country study for the Neuchatel initiative. Working Paper 154, Overseas Development Institute, London, UK, 2002.

Received 10 May 2022; accepted 15 June 2022

doi: 10.18520/cs/v123/i4/574-582