Leveraging quick response (QR) Codes for horticultural information access: A stakeholder perspective

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ABSTRACT

In the context of horticulture's crucial role in economic growth, nutritional security and employment, the sector faces challenges related to dissemination of credible scientific information, particularly in rural areas. The gap in information access leads farmers to rely on experiential knowledge and peer opinions. Leveraging information and communication technology (ICT), specifically quick response (QR) codes, presents an innovative solution to bridge this information gap. This paper investigates stakeholders' awareness, utilization, size and display distance and constraints in utilizing QR codes for accessing horticultural information. The findings indicated that 93.33% of the respondents reported previous usage, highlighting the technology's ubiquity and acceptance. Moreover, stakeholders expressed positive inclination towards QR code adoption for accessing horticultural information, with 53.33% expressing likelihood to embrace QR technology. Effect of QR code size on the display board and their display distance on the usability and adoption was also studied, which indicated, 71.22% accessed QR codes on large displays of size 8" x 11", while, 16.66% accessed them on small displays of size 4" x 5". However, despite the positive reception, several challenges impede QR code utilization. Poor internet network connectivity (mean score: 71.00) during National Horticultural Fair (NHF-2024) emerges as a significant barrier, alongside entrenched preferences for traditional methods (mean score: 69.00). By aligning QR code designs with stakeholders' preferences and addressing constraints, horticultural stakeholders can leverage QR codes more effectively, fostering knowledge dissemination and driving horticultural development.

Keywords: Information and communication technology, information dissemination, QR code, technology adoption

INTRODUCTION

In recent years, agriculture has undergone significant transformation due to advances in information and communications technology (ICT), revolutionizing traditional practices and changing food production, distribution and consumption patterns. ICT enables stakeholders in the agriculture sector to access real-time information and insights, enhancing productivity, sustainability and capacity amid evolving challenges (Abbasi et al., 2022). ICT has facilitated the development of solutions such as precision agriculture and block chain traceability systems, optimizing resources, reducing production risks, and improving compliance with international trade (Pallavi et al., 2023).

As there is a significant increase in ICT applications using mobile phones, a large proportion of farmers exhibit medium to high levels of accessibility to digital tools (Kumar, 2023). Mobile phones are essential for accessing various real-time information, including market prices, weather forecasts, agricultural advisories, and pest management information, with over 70.00 per cent of rural households owning at least one mobile phone (Fu & Akter, 2013).

Quick response (QR) codes have emerged as a powerful tool in agricultural information acquisition, dissemination, and utilization (Anonymous, 2023). QR code developed by Denso Wave (1994), is two-dimensional matrix barcodes that can store large amounts of information in a compact format (Hossain et al., 2018). Unlike traditional barcodes, QR codes can store information both vertically and horizontally, allowing access to various types of information, including uniform resource locators (URLs), text, contact information, and multimedia content.

QR codes serve as a seamless channel for sharing important agricultural information across the value chain, benefiting farmers, extension services, and

consumers' alike (Vasanthi et al., 2023). Farmers can easily access crucial information on crop management and pests, enabling them to optimize resource use and reduce production risks. Agricultural extension services utilize QR codes to disseminate educational content and improve farmers' skills in adopting new technologies and best practices. Consumers can also benefit by obtaining transparent information about products and production processes, facilitating confident and informed decision-making.

The adoption of QR codes in agricultural information dissemination enhances efficiency, accessibility, and sustainability by reducing reliance on paper-based materials. The initiative by ICAR-Indian Institute of Horticultural Research, Bengaluru, exemplifies this by providing access to a comprehensive repository of cutting-edge technologies through QR codes encoded in 12 different Indian languages. This inclusive approach ensures stakeholders from diverse linguistic backgrounds can easily access and comprehend technological innovations.

Through the strategic deployment of QR codes with multilingual content, ICAR-IIHR demonstrates a forward-thinking approach to knowledge dissemination in the horticultural domain. Building upon this initiative, the present study aims to explore stakeholders' behavior regarding QR code usage for accessing information and identify factors influencing usage behavior, as well as document constraints faced in leveraging this technology.

MATERIALS AND METHODS

Research design

The study employed *ex-post facto* approach to investigate stakeholders' behavior regarding QR code usage for accessing improved horticultural production and post-harvest technologies during National Horticultural Fair-2024 (NHF-2024) wherein large number of farmers from different parts of country have taken part for seeking horticultural information. This method enabled gathering and analyzing both quantitative and qualitative data, providing a comprehensive insight into stakeholders' behaviors and challenges about QR code usage.

Sampling

Respondents familiar with QR code technology to ensure inclusion of individuals with relevant knowledge and experience were selected purposively. Purposive random sampling ensured representation across demographics and geographic regions. Stakeholders from various horticultural sectors, including farmers, agripreneurs, farm science students, and officers in line departments and Farmer Producer Organizations (FPOs), constituted the sample, totaling 90 respondents.

Data collection and analysis

Structured interview schedule gathered quantitative data on stakeholders' awareness and usage behavior of QR codes. Semi-structured interview enabled to collect qualitative insights into stakeholders' experiences and challenges with QR code usage for accessing horticultural information in NHF-2024. Data were collected during the NHF-2024 held during March 5-7, 2024, at ICAR-Indian Institute of Horticultural Research, Bengaluru from stakeholders who visited the event. The QR codes of different sizes (8" x 11" and 4" x 5") were placed in the field during NHF-2024.

The data were tabulated and analyzed using descriptive statistics. Additionally, correlation coefficients were calculated to examine the relationships between variables.

RESULTS AND DISCUSSION

Profile of the stakeholders

The data presented in Table 1 indicated diverse personal and psychological characteristics of the respondents. More than half (54.44%) fall within the medium age group (36-55 years), while, male respondents constitute nearly two-thirds (73.33%) of the total.

Regarding education, graduates make up the largest group (41.11%), followed by diploma holders (26.67%). Occupationally, farmers represent the largest group (33.33%). About two-thirds (63.33%) of respondents have medium mass media exposure, indicating widespread access to various media sources. Additionally, over half (51.11%) displayed medium information-seeking behavior, reflecting a proactive approach to acquiring knowledge. Regarding ICT literacy, 43.33% reported medium proficiency, while, 53.33% reported medium accessibility to ICT tools. These findings underscore the need for targeted interventions to promote digital literacy and ensure equitable access.

Table 1 : Personal and psychological characteristics of the respondents (n=90)

Variable	Category	Frequency	Percentage
Age	Young (upto 35 years)	28	31.11
	Medium (36-55 years)	49	54.44
	Old (above 55 years)	13	14.44
Gender	Male	66	73.33
	Female	24	26.67
Education	Upto SSLC	16	17.78
	Diploma	24	26.67
	Graduate	37	41.11
	PG & above	13	14.44
Occupation	Farmer	30	33.33
	Agripreneur	20	22.22
	Farm science students	20	22.22
	Officers	20	22.22
Mass media exposure	Low	12	13.33
	Medium	57	63.33
	High	21	23.33
Information seeking behavior	Low	14	15.56
	Medium	46	51.11
	High	30	33.33
ICT literacy	Low	19	21.11
	Medium	39	43.33
	High	32	35.56
Accessibility of ICT tools	Low	18	20.00
	Medium	48	53.33
	High	24	26.67

Stakeholders' awareness and usage behavior towards QR codes

Vast majority of respondents (93.33%) reported having previously used QR codes (Table 2). Exposure to QR codes in educational settings and their intuitive nature further contribute to their widespread understanding and adoption (Fig. 1).

Fig. 1 : QR codes for accessing information

Among those familiar with QR codes, the most common applications reported were digital payment (78.89%) which reflects the growing popularity of cashless transactions, driven by convenience and security benefits, followed by retail and shopping (57.78%) as QR codes offer efficient ways to access product information, promotions, and loyalty programmes. Further nearly half (47.78%) of the respondents used QR codes in government services for the initiatives promoting digital governance and citizen engagement followed by marketing and advertising (48.89%) interactive advertising and consumer engagement

Concerning the frequency of QR code usage, more than half of the respondents (53.33%) reported using QR codes regularly, indicating that QR codes are an integral part of their daily activities. Only a small

Table 2 : Stakeholders' awareness and usage behavior towards QR codes (n=90)

Variable	Category	Frequency	Percentage
Have you previously used QR codes	Yes	84	93.33
	No	6	6.67
If yes, where?	Educational	16	17.78
	Digital payment	71	78.89
	Retail and shopping	52	57.78
	Government services	43	47.78
	Marketing & advertising	44	48.89
	Restaurant menus	19	21.11
	Others	10	11.11
How often do you use QR code?	Regular	48	53.33
	Occasional	36	40.00
	Never	6	6.67

percentage of respondents (6.67%) reported never using QR codes, indicating the widespread adoption of this technology among the surveyed stakeholders. Majority of respondents reporting frequent usage of QR codes suggests that they have seamlessly integrated this technology into their daily routines, likely due to its convenience and utility.

Stakeholders' experiences with QR codes for accessing horticultural information

On the perusal of data presented in Table 3 reveals insights into stakeholders' experiences with QR codes for accessing horticultural information. A majority (73.33%) successfully accessed relevant crop variety information via QR codes, affirming their effectiveness. Over half (53.33%) expressed willingness to embrace QR code usage for obtaining information. Moreover, 78.89% acknowledged QR

codes saving time compared to traditional methods. Additionally, 77.78% found QR code information meeting expectations, indicating positive reception. Furthermore, 60.00% viewed QR codes as a sustainable alternative to paper-based dissemination methods, aligning with environmental conservation goals (Durak et al., 2016). By digitizing information and making it accessible via QR codes, organizations can significantly reduce their environmental and carbon footprint and contribute to sustainable practices in the sector.

Comparison of QR code size and display distance preferences among stakeholders

Stakeholders' perspectives on QR code usage, categorized by size and display distance (Table 4). Regarding size, 71.22% accessed QR codes on large displays (8" x 11"), while, 16.66% accessed them on

Table 3 : Stakeholders' experiences with QR codes for accessing horticultural information (n=90)

Variable	Category	Frequency	Percentage
Did you access relevant information about the crop/varieties through the QR code in NHF	Yes	66	73.33
	No	24	26.67
How do you feel about the idea of having QR codes to get relevant information?	Highly likely	26	28.89
	Likely	48	53.33
	Less likely	16	17.78
Did the QR code save you time compared to traditional methods of obtaining information	Yes	71	78.89
	No	19	21.11
Did the information obtained from the QR code meet your expectations	Yes	70	77.78
	No	20	22.22
Do you think QR code can be an alternative to paper-based information dissemination?	Yes	54	60.00
	No	36	40.00

Table 4 : Comparison of QR code size and display distance preferences among stakeholders (n=66)

Variable	Category	Frequency	Percentage
Based on size	Small (4" x 5")	11	16.66
	Big (8" x 11")	47	71.22
	Both	8	12.12
Based on display distance	Near (<6')	49	74.25
	Far (>6')	5	7.57
	Both	12	18.18

small displays (4" x 5"). Additionally, 12.12% used both sizes. This preference for larger displays suggests stakeholders prefer better visibility and ease of scanning. Larger displays offer clearer images and more space for QR codes, facilitating accurate scanning.

Regarding display distance, 74.25% accessed QR codes from near distances (< 6'), while 7.57% accessed them from far distances (more than 6'). Additionally, 18.18% accessed QR codes irrespective of distances. This indicates stakeholders encounter QR codes close to their location, preferring convenience, ease of scanning, and clearer visibility. Near-distance access allows quick and effortless scanning, enhancing the user experience.

Considering these insights, it is advisable to align QR code size and display distance with stakeholders' preferences. Standardizing larger sizes (8" x 11") and recommending optimal distances (less than 6') can enhance QR code effectiveness and usability in accessing horticultural information, improving engagement and adoption.

Factors influencing usage of QR code for accessing horticultural information

Correlation coefficients (r) between various variables and their impact on QR code usage for accessing horticultural information was studied (Table 5). A negative correlation (-0.368) between age and QR code usage suggests younger individuals use QR codes more frequently due to their higher familiarity with technology. There is a significant positive correlation (0.538) between ICT literacy and QR code usage, indicating individuals with higher ICT literacy are more likely to utilize QR codes. Similarly, a strong positive correlation (0.617) exists between accessibility of ICT tools and QR code usages, implying those with greater access to digital resources are more inclined to use QR codes.

Table 5 : Factors influencing usage of QR code for accessing horticultural information (n=90)

Variables	Correlation co-efficient (r)
Age	-0.368*
Education	0.089 NS
Mass media exposure	0.142 NS
Information seeking behavior	0.187 NS
ICT literacy	0.538**
Accessibility of ICT tools	0.617**
Awareness	0.685**
Previous usage	0.289*
Frequency of usage	0.351*
Information relevancy	0.712**
Time consumption	0.406**
Size of QR code	0.614**
Placement of QR code	0.577**

NS: non-significant; ** & *: significant at 1% and 5% level, respectively

Table 6 : Constraints in utilizing QR Codes for accessing horticultural information (n=90)

Constraints	Mean score
Poor internet connectivity hindering usage of QR code	71.00
Preference for traditional methods	69.00
Limited understanding of technology i.e. how to use smart phones	60.33
Influence of social and cultural norms on adoption	57.33
Concerns about privacy and security	56.67
Challenges with device compatibility for scanning	55.67
Lack knowledge on storing and retrieving QR codes for future access	54.67
Inadequate infrastructure affecting access	54.67
Concerns about privacy and security	56.67

Awareness of QR codes shows a strong positive correlation (0.685) with usage, indicating informed individuals are more likely to utilize them. Previous usage demonstrates a positive correlation (0.289) with usage, suggesting past positive experiences influence continued utilization. Frequency of usage moderately correlates (0.351) with QR code usage, implying habitual use increases proficiency. Perceived information relevancy strongly correlates (0.712) with QR code usage, indicating their effectiveness in obtaining relevant information.

Time consumption moderately correlates (0.406) with QR code usage, suggesting those perceiving QR codes as time-saving tools utilize them more. Larger QR codes show a strong positive correlation (0.614) with usage, as do well-placed codes (0.577), indicating preferences for accessibility and readability.

Constraints in utilizing QR Codes for accessing horticultural information

Poor internet connectivity during NHF-2024, with a mean score of 71.00, highlights the challenge of providing data access in densely crowded areas due to network congestion and infrastructure limitations (Table 6). Stakeholders' preference for traditional methods (69.00) poses a significant barrier to QR code technology adoption. Despite QR codes' potential benefits in disseminating information, stakeholders hesitate to shift from familiar practices to digital solutions due to comfort, lack of awareness, technological literacy barriers, perceived risks, and cultural factors. (Heena and Bansal, 2022).

Another notable constraint was the limited understanding of technology, particularly in using smart phones (60.33). Additionally, the influence of social and cultural norms on the adoption of QR codes

(57.33) and concerns about privacy and security (56.67) were also significant constraints. These findings highlight the multifaceted challenges that need to be addressed to maximize the effectiveness of QR codes in disseminating horticultural information.

CONCLUSION

The utilization of QR codes in accessing horticultural information has emerged as a pivotal tool in transforming traditional practices and facilitating need-based knowledge dissemination in the horticultural sector. The research findings identify the utilization of QR codes among stakeholders, highlighting their effectiveness in providing relevant horticultural information. Regardless of demographics or occupation, stakeholders exhibit a positive inclination towards QR technology, influenced by factors such as age, ICT literacy, accessibility, awareness, and perceived relevance of information. Furthermore, QR codes offer a sustainable alternative to paper-based information dissemination methods *viz.*, pamphlet, booklet, folders etc., enhancing accessibility and efficiency, while, contributing to environmental conservation efforts. However, to fully realize the potential of QR codes utilization in dissemination of horticultural information, it is crucial to address challenges such as poor connectivity, preference for traditional methods etc. Recommendations for standardizing QR code size and optimal display height can further enhance their usability, accessibility/ readability and effectiveness in horticultural contexts. Moving forward, stakeholders need to prioritize sustainability in horticultural information dissemination strategies by embracing digital solutions like QR codes. Efforts to overcome constraints and promote QR code adoption will ensure their pivotal role in promoting innovation and sustainability in horticulture.

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