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Adoption and impact of weather-based agro-advisory services on climate resilience among Kinnow growers in Sirsa, District of Haryana

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Abstract

Aim: To evaluate the awareness, perception, adoption, and impact of weather-based agro-advisory services on climate resilience among kinnow growers in Sirsa district of Haryana, India.

Methodology: A cross-sectional survey was conducted in 2023-24, with 140 kinnow growers selected using random sampling. Data were collected using a structured questionnaire and analyzed using descriptive statistics, chi-square tests, perception indices, and binary logistic regression.

Results: About 87.1% of farmers were aware of agro-advisory services, with text messages as the primary dissemination channel. Rainfall advisories were perceived as most useful. Most respondents found advisories easy to understand and helpful in crop management. Approximately 82.1% reported moderate to positive improvements in production. Education and social participation significantly influenced adoption, with social participation emerging as the strongest predictor. Key constraints included untimely dissemination and technical issues, such as poor connectivity.

Interpretation: Weather-based agro-advisory services play a crucial role in improving farm decision-making and enhancing climate resilience. However, improving timeliness, accessibility, and strengthening digital infrastructure and farmer training are essential to maximize their effectiveness.

Keywords: Agro-advisory services, climate resilience, kinnow, farmer perception, weather

Introduction

Agriculture remains one of the most climate-sensitive sectors of the global economy. In India, where a significant proportion of agricultural production depends on monsoon rainfall, climate variability poses major risks to crop productivity and farm livelihoods. The increasing frequency of extreme weather events, such as droughts, heat waves, heavy rainfall, and storms, has intensified production uncertainty, particularly in semi-arid regions (IPCC, 2021) [13]. Weather-based agro-advisory services have emerged as an important tool for improving agricultural decision-making under climate variability. These services provide farmers with timely information regarding weather forecasts and recommended crop management practices, enabling them to optimize farm operations such as irrigation scheduling, fertilizer application, pest management, and harvesting. In recent years, advances in information and communication technologies (ICTs) have facilitated the widespread dissemination of agro-advisory information through mobile phones, digital platforms, and extension networks.

In India, the India Meteorological Department (IMD), in collaboration with agricultural universities and research institutions, has developed district-level agro-meteorological advisory services to support farmers in managing climate-related risks. Several studies have shown that weather-based advisory services can significantly enhance agricultural productivity and resource-use efficiency by enabling farmers to adopt climate-smart practices (Mittal & Mehar, 2016; Rao *et al.*, 2011) [18, 21]. Despite the growing availability of agro-advisory services, their effectiveness largely depends on farmers' awareness, perception, accessibility, and trust in the information provided. Socio-economic characteristics such as education, farm size, and access to digital technologies often influence the adoption of advisory services.

Understanding farmers' perception and utilization of these services is therefore essential for improving their design and delivery (Manjusree *et al.*, 2022 & Ratiya *et al.*, 2022) [25, 24]. Sirsa district of Haryana represents one of the major horticultural production regions in northern India, particularly for kinnow cultivation. However, the region is characterized by a semi-arid climate, low and erratic rainfall, and increasing temperature variability, which pose significant challenges to fruit production (Manjusree *et al.*,

2022 & Ratiya *et al.*, 2022) [25, 24]. Weather-based agro-advisory services have the potential to help farmers mitigate climate risks and improve orchard management practices. Therefore, the present study was undertaken to examine farmers' awareness, perception, and utilization of weather-based agro-advisory services and to identify constraints faced by farmers in accessing and using agro-advisory information.

Graphical abstract

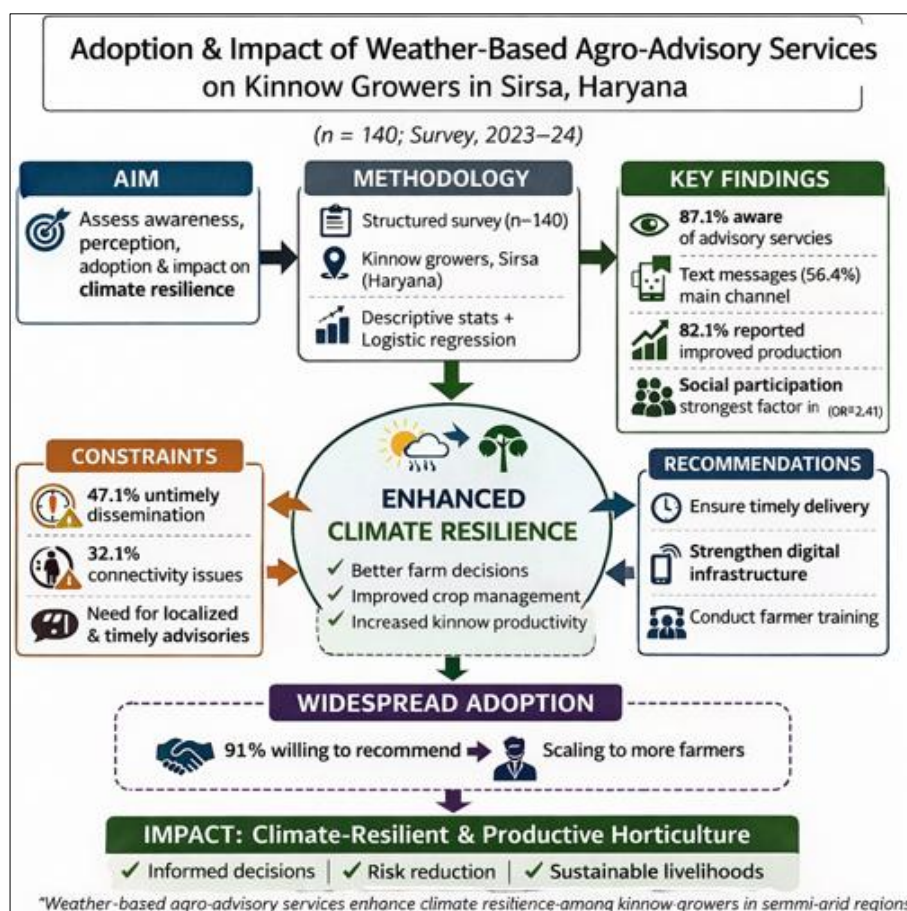


Fig 1: Adoption and impact of weather-based agro-advisory services on climate resilience among kinnow growers in Sirsa, Haryana

Materials and Methods

The study was conducted in Sirsa district of Haryana, India, a major horticultural production region characterized by semi-arid climatic conditions and high temperature variability. The district experiences an average annual rainfall of approximately 318 mm, most of which occurs during the monsoon season. A cross-sectional survey design was adopted for the study. A total of 140 horticultural farmers cultivating kinnow orchards were selected using random sampling techniques from different villages across the district during the agricultural year 2023–24. Primary data were collected through a structured questionnaire covering farmers' socio-economic characteristics, awareness and use of agro-advisory services, perceived effectiveness, utilization constraints, and crop production impacts. Data were analyzed using descriptive statistics (frequency distributions and percentage analysis)

and inferential methods. A perception index assessed farmers' attitudes toward advisory services, while constraint analysis and ranking methods identified major access-related challenges. An integrated analytical framework examined relationships among socio-economic characteristics, advisory perception, adoption behavior, and farm-level outcomes. All statistical analyses were interpreted at a 5% level of significance.

Results and Discussion

Despite the growing availability of agro-advisory services, their potential remains largely unrealized due to unequal awareness among farmers. The extent to which socio-economic characteristics determine farmers' knowledge of these services was examined using the chi-square (χ^2) test, with results presented in Table 1.

Table 1: Association between socio-economic characteristics and knowledge of agro-advisory services (n=140)

Variable	Category	Knowledge (Yes)	Knowledge (No)	χ^2 value	p-value	Significance
Age (years)	< 25	9	3	7.82	0.049	*
	25-44	86	18			
	45-65	15	6			
	> 65	2	1			
Education	Illiterate	1	2	14.36	0.006	**
	Primary	3	2			
	Higher Secondary	25	8			
	Graduate	62	11			
	Postgraduate	21	5			
Gender	Male	78	15	3.91	0.048	*
	Female	34	13			
Landholding size	Small & marginal	53	16	5.72	0.057	NS
	Medium	36	5			
	Large	23	7			
Social participation	Yes	95	11	12.64	0.001	**
	No	17	17			

The chi-square (χ^2) analysis (Table 1) reveals that farmers' awareness of agro-advisory services is systematically shaped by socio-demographic factors rather than distributed at random. Age showed a statistically significant association ($\chi^2 = 7.82$, $p = 0.049$), with the 25-44 age group achieving the highest awareness rate (83%), driven by a combination of practical experience and technological adaptability. Awareness dropped notably among older farmers (>65 years: 67%), reflecting lower digital literacy, and among the youngest cohort (<25 years: 75%), attributable to limited farming exposure (Aryal *et al.*, 2018; Appiah & Guodaar, 2022; BIRTHAL *et al.*, 2025) [2, 29, 4]. The findings suggested that education was the most statistically robust predictor ($\chi^2 = 14.36$, $p = 0.006$). Postgraduate and graduate farmers demonstrated awareness rates of 81% and 85%, respectively, in stark contrast to illiterate farmers (33%). Education equips farmers to interpret technical advisories, engage digital platforms, and utilize institutional extension services effectively. The wide awareness gap among less-educated farmers underscores the urgent need for simplified, multilingual communication formats (Aker *et al.*, 2016; Mittal & Mehar, 2016) [1, 18]. However, gender showed a significant association ($\chi^2 = 3.91$, $p = 0.048$), with male farmers recording an 84% awareness rate versus 72% among females. This gap reflects deep-rooted socio-cultural barriers, unequal resource access, and women's limited representation in formal agricultural training impediments well-documented as critical constraints on women's access to climate information (FAO, 2023; Witinok-Huber & Radil, 2021; Gumucio *et al.*, 2020) [10, 19, 12]. The size of landholding was the only non-significant variable ($\chi^2 = 5.72$, $p = 0.057$). Although medium farmers showed a slightly higher awareness rate (88%), differences across farm categories were not statistically meaningful. This is a policy-encouraging finding, indicating that mobile-based digital advisory platforms are progressively bridging resource-based disparities among smallholders and large farmers alike (Tamru *et al.*, 2025; Ramaraj *et al.*, 2023) [3,

20]. As per the data stipulated in Table 1, social participation emerged as the single strongest predictor ($\chi^2 = 12.64$, $p = 0.001$), with socially active farmers achieving 90% awareness compared to just 50% among non-participants, a 40-percentage-point gap. Engagement in farmer groups, extension programmes, and community networks facilitates peer learning, technology exposure, and institutional trust all critical pathways to advisory adoption (Krishna *et al.*, 2013; Teklewold, 2023) [14, 26]. The study revealed that education and social participation stand out as the dominant determinants of advisory awareness. These findings affirm that scaling agro-advisory uptake demands a multi-dimensional strategy: strengthening human capital, expanding inclusive social networks, bridging gender divides, and investing in simplified digital extension infrastructure capable of reaching even the least-resourced farmers. Among the explanatory variables, education emerged as a highly significant determinant ($\beta = 0.64$, $p = 0.002$) with an odds ratio of 1.89, indicating that an increase in education level nearly doubles the likelihood of adopting agro-advisory services. Education enhances farmers' ability to comprehend weather forecasts, interpret advisory messages, and utilize digital platforms effectively. Similar findings have been reported in recent studies, where education significantly influenced the adoption of ICT-based agricultural services and climate-smart practices (Aryal *et al.*, 2018; Aker *et al.*, 2016) [2, 1]. Social participation was found to be the strongest predictor of adoption ($\beta = 0.88$, $p = 0.001$), with an odds ratio of 2.41, indicating that socially active farmers are more than twice as likely to adopt agro-advisory services. This highlights the critical role of social networks, farmer groups, and community interactions in facilitating the dissemination and acceptance of agricultural innovations. Social learning and peer influence have been widely recognized as key drivers of technology adoption in rural contexts (Krishna *et al.*, 2013; Fabregas *et al.*, 2019) [14, 9].

Table 2: Determinants of adoption of agro-advisory services among farmers

Variable	Coefficient (β)	Standard Error	Odds Ratio	p-value
Age	-0.12	0.07	0.89	0.081
Education	0.64	0.19	1.89	0.002
Land holding	0.41	0.18	1.51	0.021
Annual income	0.29	0.15	1.34	0.054
Farming experience	0.36	0.14	1.43	0.011
Social participation	0.88	0.24	2.41	0.001
Constant	-1.67	0.53	-	0.002

Dependent variable: Adoption of agro-advisory services (Yes=1, No=0)

Nagelkerke $R^2 = 0.41$, $\chi^2 = 38.7$ ($p < 0.001$)

The data in Table 2 indicate determinants of adoption of agro-advisory services among farmers. Landholding size had a significant positive effect on adoption ($\beta = 0.41$, $p = 0.021$), as larger farmers possess greater financial capacity and risk-bearing ability to experiment with new information systems, consistent with evidence that resource endowment facilitates climate information service adoption (Appiah & Guodaar, 2022; BIRTHAL *et al.*, 2014) [29, 5]. Farming experience was similarly positively associated ($\beta = 0.36$, $p = 0.011$), reflecting experienced farmers' enhanced ability to evaluate advisory relevance and integrate it into farm management decisions (Rao *et al.*, 2011; Tamru *et al.*, 2025) [21, 3]. Annual income showed a positive but marginally non-significant effect ($\beta = 0.29$, $p = 0.054$), suggesting that economic capacity may still facilitate access to digital tools and paid advisory platforms, a trend documented in broader digital agriculture literature (Trendov *et al.*, 2019; World Bank, 2019) [11, 31]. In contrast, age exhibited a negative and non-significant effect ($\beta = -0.12$, $p = 0.081$), indicating that older farmers' slightly lower adoption likelihood is largely mediated by education and social participation rather than age alone (Aryal *et al.*, 2018) [2]. The results of this study are consistent with a growing body of literature emphasizing the role of socio-economic and institutional factors in shaping the adoption of climate information services. For instance, Aker *et al.* (2016) [1] highlighted the importance of ICT access and education in improving agricultural advisory

uptake, while Tamru *et al.* (2025) [3] emphasized the role of trust and reliability in climate information services. Similarly, Aryal *et al.* (2018) [2] and Appiah & Guodaar (2022) [29] reported that farm size, education, and experience significantly influence the adoption of climate-smart agricultural practices. The strong influence of social participation observed in this study also aligns with findings from Krishna *et al.* (2013) [14], who emphasized the role of social networks in accelerating the diffusion of agricultural innovations.

The results presented in Table 3 reveal clear and statistically significant patterns in farmers' access, awareness, and utilization of agro-advisory services. A large majority of farmers (87.1%) were aware of agro-advisory services, with a highly significant difference ($\chi^2 = 67.20$, $p < 0.001$), indicating widespread dissemination and strong awareness levels. This reflects the growing reach of ICT-based agricultural extension systems (Aker *et al.*, 2016; Dupdal, 2023) [1, 7].

Among the sources of awareness, CCS Haryana Agricultural University (35%) was the dominant source, followed by social media and NGOs, with significant variation across sources ($\chi^2 = 12.86$, $p = 0.005$). This suggests that farmers rely more on credible institutional and digital platforms than informal channels, highlighting the increasing role of formal institutions and digital media in knowledge dissemination (Trendov *et al.*, 2019; World Bank, 2019) [11, 31].

Table 3: Access, awareness, and utilization behavior of agro-advisory services among kinnow farmers (n = 140)

Variable	Category	Frequency	Percentage (%)	Rank	χ^2 value	p-value
Knowledge of advisories	Yes	122	87.1	I	67.20	<0.001**
	No	18	12.9	II		
Source of awareness	CCS HAU Hisar	49	35.0	I	12.86	0.005**
	Social media/NGOs	37	26.4	II		
	State Agri. Dept.	29	20.7	III		
	Fellow farmers	25	17.9	IV		
	Text messages	79	56.4	I	102.3	<0.001**
Channels of receiving advisories	Apps/social media	28	20.0	II		
	Voice calls	15	10.7	III		
	Fellow farmers	14	10.0	IV		
	Mass media	4	2.9	V		
Frequency of usage	Daily	46	32.9	I	42.15	<0.001**
	Occasionally	45	32.1	II		
	Weekly	23	16.5	III		
	Never	17	12.1	IV		
	Monthly	9	6.4	V		
Verification of advisories	Yes	109	77.9	I	44.11	<0.001**
	No	31	22.1	II		
Verification source	Agricultural scientists	42	30.0	I	19.72	0.001**
	Fellow farmers	37	26.4	II		
	Own experience	27	19.4	III		
	Others/online	17	12.1	IV		
	Agro-advisories	17	12.1	IV		

Regarding communication channels, text messages (56.4%) emerged as the most preferred mode, with a very high chi-square value ($\chi^2 = 102.3$, $p < 0.001$), indicating a strong and non-random preference for SMS-based advisories. This supports the effectiveness of mobile-based communication systems in delivering timely agricultural information, particularly in resource-constrained settings (Fabregas *et al.*, 2019; Mittal & Mehar, 2016; Tamru *et al.*, 2025) [9, 18, 3].

The frequency of usage showed variability, with daily (32.9%) and occasional (32.1%) use dominating, and a significant difference across categories ($\chi^2 = 42.15$, $p <$

0.001). This reflects heterogeneity in adoption behavior, suggesting that farmers use advisories either routinely or situationally depending on climatic conditions and perceived relevance (Rao *et al.*, 2011) [21].

A substantial proportion of farmers (77.9%) reported verifying advisory information before use, with strong statistical significance ($\chi^2 = 44.11$, $p < 0.001$), highlighting the importance of trust in decision-making. Verification was primarily done through agricultural scientists (30%) and fellow farmers (26.4%), with significant variation among sources ($\chi^2 = 19.72$, $p = 0.001$), indicating reliance on both

formal expertise and social networks. This behavior reflects risk-averse decision-making under climatic uncertainty (Tamru *et al.*, 2025; Aryal *et al.*, 2018) [3, 2].

The results presented in Table 4 demonstrate that farmers exhibit strong and statistically significant perceptions regarding the usefulness and impact of agro-advisory services, as indicated by highly significant chi-square values ($p < 0.001$) across all variables. A majority of farmers

(57.1%) perceived all weather parameters as equally important, with a significant difference ($\chi^2 = 78.54$, $p < 0.001$), indicating that farmers recognize the multidimensional nature of climate risks. This highlights the need for integrated advisory services that combine rainfall, temperature, and extreme weather information (Appiah & Guodaar, 2022; Tamru *et al.*, 2025) [29, 3].

Table 4: Farmers' perception, usefulness, and impact of agro-advisory services on kinnow production (n = 140)

Variable	Category	Frequency	Percentage (%)	Rank	χ^2 value	p-value
Useful weather parameter	All parameters	80	57.1	I	78.54	<0.001**
	Rainfall	46	32.9	II		
	Temperature	7	5.0	III		
	Wind/hailstorm	7	5.0	III		
Important crop stage	All stages	95	67.9	I	135.6	<0.001**
	Irrigation/fertilization	25	17.9	II		
	Pest control	10	7.1	III		
	Flowering	9	6.4	IV		
	Harvesting	1	0.7	V		
Timely availability	Yes	88	62.8	I	68.92	<0.001**
	Mostly yes	32	22.9	II		
	Mostly no	12	8.6	III		
	No	8	5.7	IV		
Ease of understanding	Easy	88	62.9	I	72.11	<0.001**
	Mostly easy	32	22.8	II		
	Mostly difficult	12	8.6	III		
	Difficult	8	5.7	IV		
Accuracy of advisories	Excellent	64	45.7	I	51.84	<0.001**
	Fair	44	31.4	II		
	Good	18	12.9	III		
	Very poor	9	6.4	IV		
	Poor	5	3.6	V		
Usefulness	Very helpful	64	45.8	I	49.23	<0.001**
	Somewhat helpful	37	26.4	II		
	Neutral	27	19.3	III		
	Not very helpful	9	6.4	IV		
	Not helpful	3	2.1	V		
Impact on production	Moderate change	77	55.0	I	82.17	<0.001**
	Positive change	38	27.1	II		
	No change	23	16.5	III		
	Negative change	2	1.4	IV		

Similarly, 67.9% of farmers reported that advisories are important across all crop growth stages, with a very high chi-square value ($\chi^2 = 135.6$, $p < 0.001$). This suggests that farmers consider agro-advisories as a continuous decision-support tool rather than a stage-specific intervention, aligning with the principles of climate-smart agriculture (Aryal *et al.*, 2018; Venkatramanan & Shah, 2019) [2, 30].

Perception of service quality was also high, with 62.8% of farmers reporting timely availability ($\chi^2 = 68.92$, $p < 0.001$) and 62.9% indicating that advisories are easy to understand ($\chi^2 = 72.11$, $p < 0.001$). These findings suggest that the delivery mechanisms and communication formats of advisory services are largely effective. However, the presence of responses indicating delays and difficulty suggests scope for further improvement in localization and clarity. In terms of accuracy, 45.7% of farmers rated advisories as excellent, followed by 31.4% rating them as fair, with a significant variation ($\chi^2 = 51.84$, $p < 0.001$). This indicates that while overall confidence in advisory accuracy is high, inconsistencies in forecast precision may influence farmers' trust. Forecast uncertainty remains a known limitation in agro-meteorological services, particularly in semi-arid regions (Tamru *et al.*, 2025) [3]. The perceived

usefulness of agro-advisory services was notably high, with 45.8% of farmers considering them very helpful and 26.4% somewhat helpful, supported by a significant chi-square value ($\chi^2 = 49.23$, $p < 0.001$). This confirms that farmers clearly recognize the practical benefits of advisory services in farm management decisions. Comparable levels of farmer satisfaction and perceived usefulness of weather-based agro-advisory services have also been reported in other Indian regions (Kumar *et al.*, 2021) [15]. Regarding impact, a majority of farmers (55.0%) reported moderate improvement in kinnow production, with a highly significant difference ($\chi^2 = 82.17$, $p < 0.001$). This suggests that agro-advisory services contribute positively to agricultural outcomes by improving the timing and efficiency of farm operations such as irrigation, pest control, and nutrient management. Similar findings have been reported in studies highlighting the role of climate information services in enhancing productivity and resilience (Maini & Basu, 2016; Rao *et al.*, 2011) [22, 21]. Similar economic and farm-level benefits of agrometeorological advisory services have been reported elsewhere (Dupdal *et al.*, 2020) [8]. The findings emphasize that improving timeliness, accuracy, and user-specific

customization of advisories can further enhance their effectiveness and impact. These findings are consistent with earlier evidence showing positive farmer perceptions and perceived advantages of weather-based agro-advisory services (Manjusha *et al.*, 2019) ^[16].

Constraints affecting advisory utilization and their mitigation

The key problems faced by farmers while using weather-based agro-advisory services are illustrated in Fig. 2.

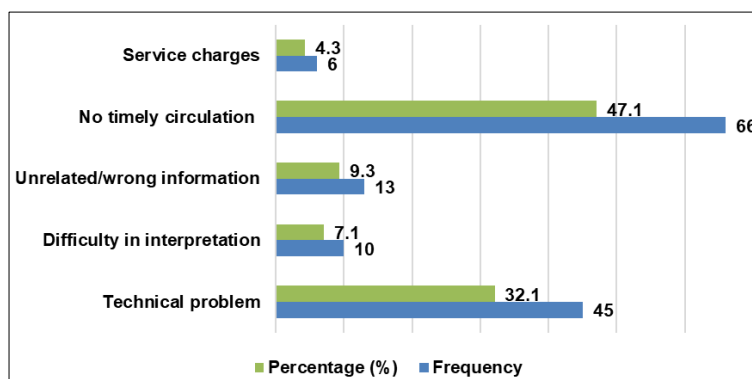


Fig 2: Problems faced by farmers while using weather-based advisories

The predominance of untimely advisory circulation (47.1%) is particularly concerning given the inherently time-sensitive nature of weather-based recommendations, where even minor delays can render crop management advice obsolete. Rathore *et al.* (2025) ^[23] established that advisory decision-utility is critically dependent on last-mile delivery speed, while Gitau *et al.* (2025) ^[6] emphasised that real-time mobile dissemination is essential under increasing weather variability. Technical problems (32.1%) reflect the infrastructural fragility of rural digital systems, where poor connectivity, low smartphone penetration, and unreliable electricity collectively impede advisory access barriers documented by Gouroubera *et al.* (2023) ^[28] and Ma *et al.* (2023) ^[27] as the foremost systemic constraints to ICT-based advisory adoption in South Asian smallholder systems, underscoring the need for hybrid delivery models

integrating digital platforms with community-level extension intermediaries.

Unrelated or wrong information (9.3%) and difficulty in interpretation (7.1%) collectively reflect gaps in advisory quality, localisation, and communication design. De Roo *et al.* (2019) ^[17] highlighted that credibility is contingent on hyper-local relevance, while Ramaraj *et al.* (2023) ^[20] demonstrated that comprehension improves significantly through simplified regional-language advisories with visual aids and action-oriented recommendations. Notably, service charges (4.3%) remained the least cited barrier, consistent with Mittal and Mehar (2016) ^[18], who found that willingness to pay rises once farmers perceive demonstrable utility reinforcing that improving timeliness and content quality is a far more effective adoption lever than subsidy-based cost reduction.

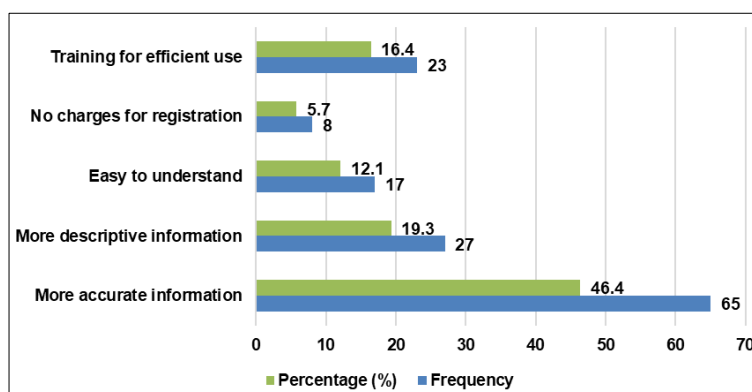


Fig 3: Factors to be improved in agro-advisories

Fig. 3 shows the key improvements farmers expect in agro-advisory services. The most prominent demand was for more accurate information (46.4%, n=65), followed by more descriptive information (19.3%, n=27), training for efficient use (16.4%, n=23), easy-to-understand content (12.1%, n=17), and removal of registration charges (5.7%, n=8).

Overall, farmers prioritised quality, accessibility, and usability over cost concerns.

The strong emphasis on accuracy highlights it as the primary driver of trust and sustained use, as inaccurate forecasts can lead to poor decisions and reduced confidence. This aligns with de Roo *et al.* (2019) ^[17], who identified

perceived accuracy as the key determinant of advisory engagement, and Gitau *et al.* (2025) ^[6], who showed that improved local forecast precision increases farmers' willingness to act, underscoring the need for better meteorological infrastructure and real-time satellite integration. The demand for more descriptive information indicates a need for crop-specific, actionable guidance rather than generic forecasts. Ramaraj *et al.* (2023) ^[20] and Rathore *et al.* (2025) ^[23] similarly emphasised that contextualised, action-oriented advisories improve adoption and decision-making among smallholders. Requests for training (16.4%) and simpler content (12.1%) reveal gaps in capacity and communication. Gouroubera *et al.* (2023) ^[28] and Ma *et al.* (2023) ^[27] identified low digital literacy as a major barrier to ICT-based advisory use, while Mittal and Mehar (2016) ^[18] showed that simplified language and visual/audio formats enhance understanding among less-educated farmers. Finally, the low demand for removing registration charges (5.7%) confirms that cost is a minor concern compared to service quality. Overall, the findings suggest that policy efforts should focus on improving forecast accuracy, localising content, simplifying communication, and strengthening farmer capacity to maximise the impact of weather-based agro-advisory services.

Conclusion

The study demonstrates that weather-based agro-advisory services have considerable potential to improve climate resilience and farm-level decision-making among Kinnow growers in Sirsa district. The high level of farmer awareness, perceived usefulness and reported production benefits indicates that timely, accurate and crop-specific weather information can support better decisions related to irrigation, plant protection and other weather-sensitive orchard operations. However, delays in information delivery, technical problems, information quality and difficulties in interpretation remain important constraints. The findings provide a basis for developing farmer-friendly, village- and block-level agro-advisory policies in Haryana. Advisories should be localized according to crop stage, weather risk and farmers' information needs and delivered through multiple accessible channels, including SMS, WhatsApp, voice messages, KVKs and extension personnel. Greater emphasis on local weather observations and simple, actionable messages can further improve their effectiveness. The study also highlights the potential to link weather advisories with Pradhan Mantri Fasal Beema Yojna (PMFBY) and Mukhyamantri Bagwani Beema Yojna (MBBY) as complementary components of climate risk management. Weather advisories can help farmers anticipate weather risks and undertake preventive measures, while PMFBY and MBBY provide financial protection against eligible crop losses that occur despite such measures. Thus, a coordinated framework of weather information → localized advisory → preventive action → insurance protection can help Haryana move towards a more anticipatory, climate-resilient and farmer-centred agricultural policy. The approach can also be replicated for other crops and districts facing increasing weather and climate risks.

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