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MASS MEDIA AS AN AGRICULTURAL INFORMATION SOURCE FOR FARMERS IN PUNJAB, PAKISTAN: AN EFFECTIVENESS ANALYSIS ACROSS AGRO-ECOLOGICAL REGIONS

LOS MEDIOS DE COMUNICACIÓN COMO FUENTE DE INFORMACIÓN AGRÍCOLA PARA LOS AGRICULTORES DE PUNJAB, PAKISTÁN: UN ANÁLISIS DE SU EFICACIA EN DISTINTAS REGIONES AGROECOLÓGICAS

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Abstract
This research aims to investigate the effectiveness of mass media as a source of agricultural information for farmers across the agro-ecological regions of Punjab, Pakistan. The study was conducted in five purposively selected agro-ecological zones of the province. Data were collected from 500 randomly selected respondents through face-to-face interviews using an interview schedule and analyzed using SPSS. Descriptive and inferential statistics were used for the interpretation of data. Respondents across different agro-ecological zones showed significant variation in the use of different mass media information sources. This has been concluded that different mass media information sources serve diverse information needs of farmers. Findings concluded that mass media

Resumo
Esta pesquisa tem como objetivo investigar a eficácia da mídia de massa como fonte de informação agrícola para os agricultores das regiões agroecológicas de Punjab, no Paquistão. O estudo foi realizado em cinco zonas agroecológicas da província, selecionadas propositalmente. Os dados foram coletados de 500 entrevistados selecionados aleatoriamente por meio de entrevistas presenciais, utilizando um roteiro de entrevista, e analisados com o SPSS. Estatísticas descritivas e inferenciais foram utilizadas para a interpretação dos dados. Os entrevistados de diferentes zonas agroecológicas mostraram variações significativas no uso de diferentes fontes de informação da mídia de massa. Concluiu-se que diferentes fontes de informação

shows significant effectiveness in various aspects of agricultural development, particularly in increasing farm yield, income, and knowledge, improving farmer confidence, and enhancing linkages with other stakeholders. The role of mass media in enhancing agricultural practices varies significantly by agro-ecological regions. The regression model significantly predicted the effectiveness of mass media information sources ($R^2 = 0.742$, $p < 0.001$), with frequency of use, usefulness, relevancy of information received, and time of usage making statistically significant positive predictors. These findings recommended that there is a need to improve rural digital infrastructure, develop region-specific and accessible content, increase media diversity and frequency, and promote digital literacy among farmers. Additionally, fostering collaboration with agricultural institutions, leveraging mobile platforms, and using a multi-channel communication approach can significantly improve the reach, relevance, and adoption of agricultural information by the farmers.

Keywords: Information Sources. Mass Media. Agriculture Information. Farmers. Pakistan.

da mídia de massa atendem a diversas necessidades de informação dos agricultores. Os resultados concluíram que a mídia de massa mostra eficácia significativa em vários aspectos do desenvolvimento agrícola, particularmente no aumento da produtividade agrícola, da renda e do conhecimento, melhorando a confiança dos agricultores e fortalecendo os vínculos com outras partes interessadas. O papel da mídia de massa no aprimoramento das práticas agrícolas varia significativamente de acordo com as regiões agroecológicas. O modelo de regressão previu significativamente a eficácia das fontes de informação da mídia de massa ($R^2 = 0,742$, $p < 0,001$), com a frequência de uso, a utilidade, a relevância das informações recebidas e o tempo de uso sendo preditores positivos estatisticamente significativos. Essas conclusões recomendaram a necessidade de melhorar a infraestrutura digital rural, desenvolver conteúdo específico para cada região e acessível, aumentar a diversidade e a frequência da mídia e promover a alfabetização digital entre os agricultores. Além disso, fomentar a colaboração com instituições agrícolas, aproveitar as plataformas móveis e usar uma abordagem de comunicação multicanal pode melhorar significativamente o alcance, a relevância e a adoção de informações agrícolas pelos agricultores.

Palavras-chave: *Fontes de Informação. Mídia de Massa. Informação Agrícola. Agricultores. Paquistão.*

1 INTRODUCTION

Agriculture is vital for livelihoods globally, especially in developing regions like Pakistan, where most of the people rely on farming to secure their livelihoods. it is essential and crucial for the livelihoods of many people around the globe. It supplies food, feed, fuel, fiber, and industrial products. A diverse and complex sector, essential for human existence and activity, ensures the continuous provision of resources for a growing world population (Velten et al., 2015). Concerning Pakistan, sustainable growth in the agriculture sector is very much essentialfor sustainable food security and sustainable rural development in the country. The agriculture sector is equally important in Pakistan, like other developing regions of the world. It is the single largest sector that accounts for

around 22.7% of GDP. Its share in the total labour force is also high, that is 38.0% (Government of Pakistan, 2024).

For increasing farm productivity and household income, access to reliable and credible agricultural information is essential (Naveed & Anwar, 2013, 2015; Naveed & Hassan, 2021). For providing such information to farmers, the mass media has long played a pivotal role in disseminating agricultural information to farmers, offering a means to bridge knowledge gaps and promote the adoption of improved practices (Harry & Chukuigwe, 2025; Javaid 2017; Khan et al., 2020; Nwabueze, 2024). Traditional channels such as radio, television, and print media have been widely used to reach rural populations, with studies showing that television and radio are often the most trusted and effective sources for learning about new agricultural technologies, despite barriers like affordability, illiteracy, and technical issues (Adeyeye & Salawu, 2025; Pathak & Patel, 2022; Rahman et al., 2024; Shaikh et al., 2020; Yadavet al., 2020). Print media, including newspapers and pamphlets, also remain important, especially when tailored to the needs and literacy levels of local communities (Pathak & Patel, 2022; Rahman et al., 2024; Shitaye, Tadesse & Enkuahone, 2025).

Recent research highlights the growing influence of digital platforms, with social media and mobile apps emerging as powerful tools for agricultural information exchange. These platforms facilitate rapid dissemination, interactive learning, and peer-to-peer sharing, with a significant proportion of farmers reporting enhanced knowledge and practical benefits from their use (Dawid & Boka, 2025; Sandeep et al., 2022; Madhushekar et al., 2024). However, the effectiveness of mass media as an agricultural information source is not uniform; it varies by region, media type, and the socioeconomic characteristics of the target audience (Akhter, Hussain, & Ahsan, 2021; Akwiwu, & Patrick, 2020; Naveed, Anwar & Bano, 2012; Naveed & Hassan, 2021). Barriers such as limited access to technology, low digital literacy, and economic constraints can hinder the reach and impact of mass media campaigns, underscoring the need for context-specific strategies (Akwiwu & Patrick, 2020; Dhakal, 2025; Naveed & Anwar, 2013; 2014; 2015; Rahman et al., 2024). Integrating multiple communication channels, combining mass media with interpersonal methods and culturally relevant formats, has been shown to maximize coverage and effectiveness, ensuring that diverse farmer populations receive and can act on critical agricultural information (Dhakal, 2025; Naveed & Suhaib, 2019); Tamboe et al., 2023).

In this context, the influence of mass media on the adoption of innovative agricultural practices and the needs of farmers to choose a specific mass media information source need to be explored. Despite the availability of information through mass media, farmers are facing a number of barriers in accessing credible and actionable agricultural information (Akwiwu & Patrick, 2020; Ariyo et al., 2013; Dhakal, 2025; Ohara, Obu & Ogar, 2023). This hinders farmers' ability to adopt improved agricultural practices that ultimately affect their farm productivity, income, and household food security. With this background, there is a need to evaluate the effectiveness of mass media as an agricultural information source.

2 THEORETICAL FRAMEWORK

The current research study implies two theories that explain how respondents (farming community) receive, pursue, and act upon agricultural-related information from different mass media information sources (Figure 1). First is the Diffusion of Innovation Theory (DOIT) given by Rogers (2003), which explains how innovative agricultural technologies, ideas, or practices diffuse within a social system over time. As per this theory, Mass media play a crucial and significant role in the innovation-decision process at the knowledge and persuasion stages by raising awareness among members of the social system about updated agricultural technologies and practices. Mass media influence the rate of adoption of innovative agricultural technologies and the perceived benefits of these innovations. It may also affect the decision-making process of farmers about updated agricultural innovations. Mass media information tools help farmers in bridging the information gap through the provision of credible, timely, and actionable agricultural knowledge and information.

Second is the Uses and Gratifications Theory (UGT) which explains why and how people are interested in seeking specific information to satisfy their specific needs and priorities from different mass media information sources. This theory was presented by Blumler & Katz (1974). Concerning the present research study, the farming community chose a specific mass media as an agricultural information source on the basis of their ease of access, relevancy to their farming needs, and perceived usefulness, as different mass media information sources fulfill different needs of the farming community. This theory also helps in explaining variations in using a specific mass media as a preferred

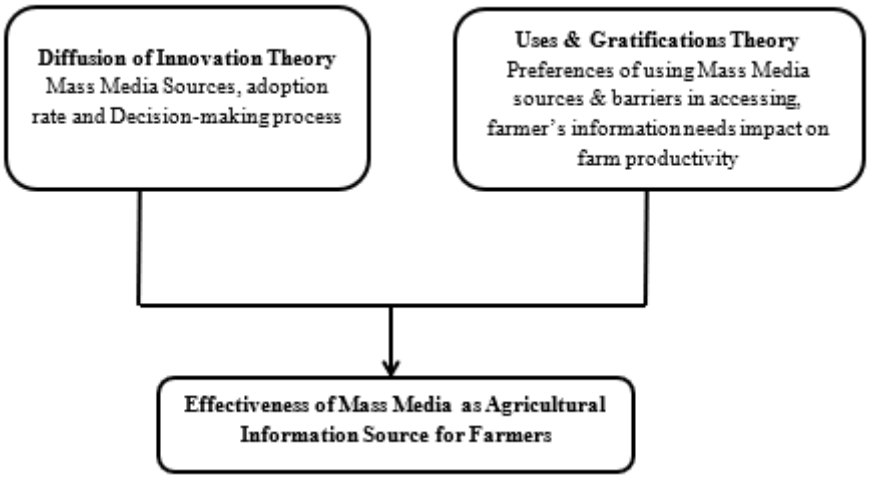
agricultural information source, frequency of usage, and their satisfaction level across different socio-economic groups belonging to different agro-ecological zones. Integration of these two theories enabled to have deep understanding about the following research questions of the study:

1. How is information regarding updated agricultural innovations disseminated to the farmers?
2. Why and how farming community use different mass media information sources to fulfill their farming needs and priorities?

This theoretical integration helps in assessing the effectiveness of different mass media information sources being used by the farmers of the research area, barriers in accessing and using, including impact on the acquisition of agricultural knowledge, and ultimately their farm productivity. Within the context of agricultural and rural development, these two theories were also cited by Ali & Kumar (2021) and Zhai et al. (2018). In rural areas of Pakistan, traditional agricultural extension and information sources have not so effectively played a role in reaching the real needs of farmers due to limited access to agricultural extension agents. And thus, farmers rely mostly on different mass media agricultural information sources for easy and in time access.

Figure 1

Theoretical integration



3 METHODOLOGY

3.1 Research design and approach

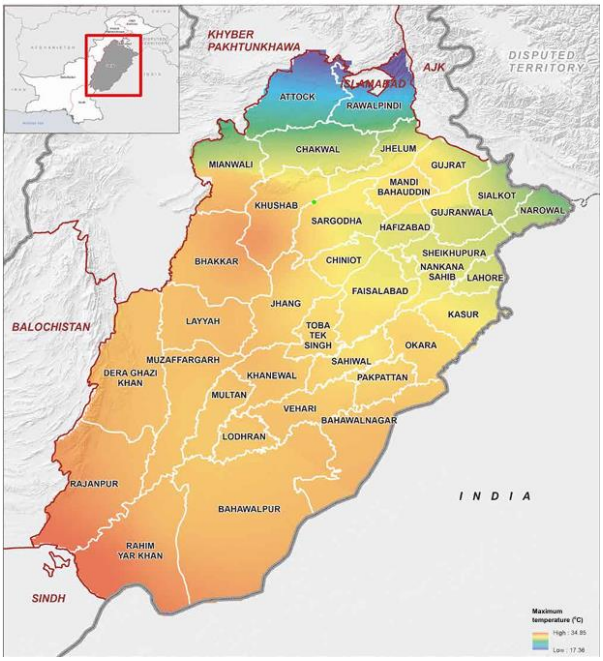
The design and procedures or plan that comprises different steps of data collection, analysis of collected data, and its interpretation is regarded as a research approach (Creswell, 2013). Main types of research designs in social sciences are categorized as descriptive, experimental, correlational, diagnostic, and explanatory. In the present research study, a descriptive as well as correlational design was used.

3.2 Study area: Punjab province

The present study was conducted in the Punjab, which is the most populated province of Pakistan. It is located at 72.70o E and 31.17o N. It lies in the arid and semi-arid region of Pakistan. Temperature ranges from -2°C to 45 °C. The temperature goes higher in peak summer and lower in peak winter. Humidity in the Punjab province ranges from 53% to 62% depending on the climatic variability (Government of Pakistan, 2024). A map of the Punjab showing its different districts is given in the following Figure 2:

Figure 2

Map of the study province (Punjab)

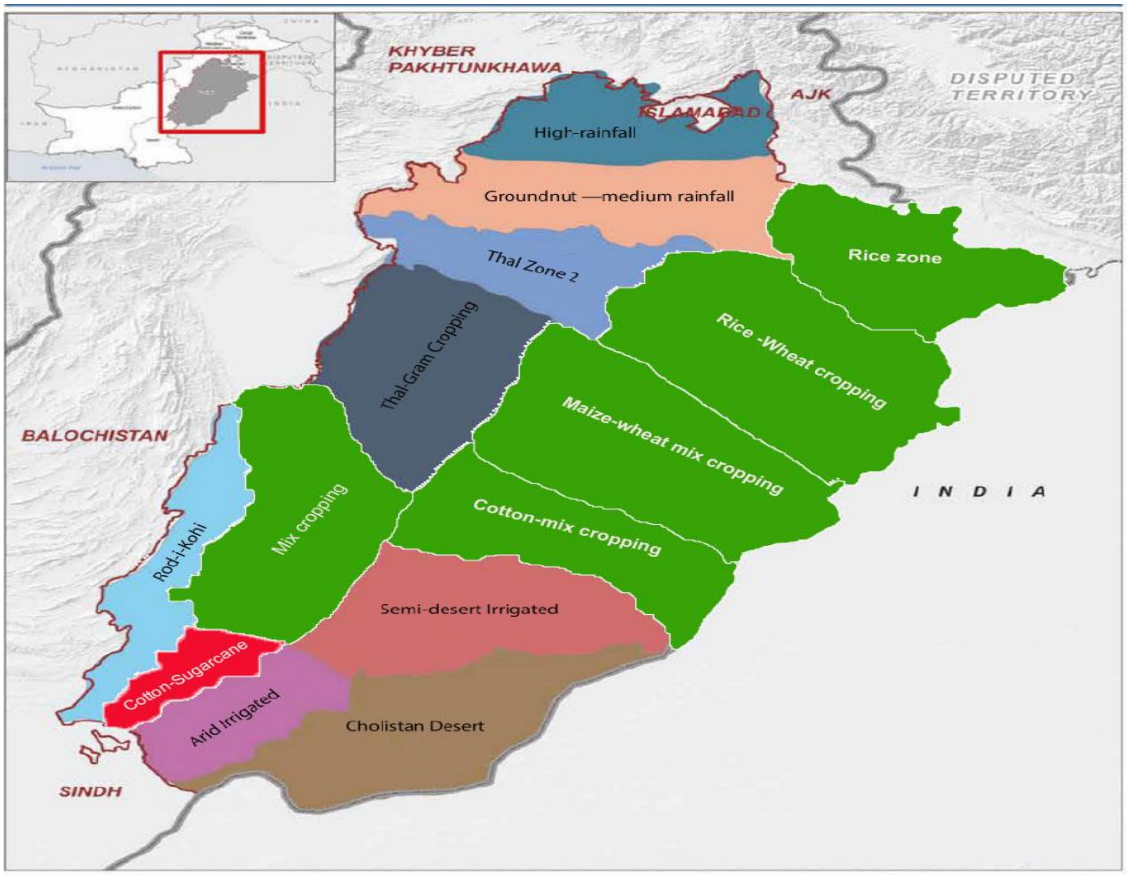


3.3 Targeted study districts

Depending upon climatic factors, Punjab province is divided into 14 (fourteen) agro-ecological zones as per classification defined by FAO (2019) as presented in Figure 02. Data were collected from five (05) purposively selected agro-ecological zones of the Punjab province as highlighted in the green colour in the following Figure 3.

Figure 3

Targeted research areas (Agro-ecological zones) of the Punjab, Pakistan



3.4 Data sources

Both primary and secondary data sets were used in the present study. Personal face-to-face method was used for the collection of information and data under the present research study. For this purpose, the researcher personally visited and targeted the place of respondents and hold face-to-face interviews to collect the required information. The collected data were original, and the level of accuracy and reliability of the collected data

was high. The questions were modified according to the educational, social, economic, and motivational level of the respondents. Some secondary data were also collected from multiple sources.

Population, sample, and sampling procedure/technique

The targeted population of this research study was the farmers of the Punjab province. In the present research study probability (simple random) sampling procedure was adopted to provide an equal and fair opportunity available to all the participants to get selected. In addition to probability sampling, a non-probability sampling procedure was also adopted for the selection of targeted 05 (five) agro-ecological zones out of the total 14 (fourteen) of the Punjab province (targeted study province). From each cropping zone, 100 farmers were randomly selected and personally interviewed for data collection. The total sample size for the current research study was 500 farmers.

Data collection tool

A structured interview schedule was used as a data collection tool. Both open and closed-ended questions were asked to collect the information. The validity and reliability of the interview schedule were tested by using Cronbach's Alpha and a sample of 25 instruments.

Data analysis and interpretation

Descriptive statistics was computed for each variable (Frequency distribution for all categorical). The dependent variable of the study was the mass media methods being used by the farmers (frequency of use, usefulness, time of use). Independent variables were related to the socio-economic characteristics of respondents. Chi-Square test of proportions was used to test the equality of proportions for different usage levels [Not at all, rarely, occasionally & mostly]. Two-way contingency tables were generated for different socio-economic attributes with mass media sources as the dependent variable. Chi-Square test of Association was used to test the association between different socio economics attributes and mass media sources. Significance was observed at 5% level of significance. Multiple regression model was used to find out the individual and combined effect of several independent variables (Time of the using mass media (T), Frequency of use (F), relevancy (R) and usefulness of information received (U) on the effectiveness of mass media sources. Following formula was formulated:

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + e \qquad (1)$$

$$E= B_0 + B_1 T_1 + B_2F_2 + B_3R_3 + B_4U_4 + e \quad (2)$$

Statistically, the use of a multiple regression model in this study is appropriate as our objective is to predict the outcome and explain the relationship between multiple continuous or ordinal independent variables and a single continuous dependent variable. Sources justify the use of this model for such studies as Creswell, J. W. (2014) and Islam, M. S., & Grönlund, Å. (2011).

4 RESULTS AND DISCUSSION

4.1 Usage of mass media information sources for agricultural information

Usage of different agricultural information sources by the respondents belonging to different agro-ecological zones (five different data collection regions) and chi-Square test of independence is hereby presented in the following Table 1:

Table 1

Usage of mass media information sources across ago-ecological zones

Mass media *agri. information sources*	**Scale**	**Agro-Ecological Zone**					**Chi-Square**	**p-Value**
		Rice-Wheat	**Mix**	**Rice**	**Cotton Mix**	**Maize-Wheat**		
Print media Agri. Information sources								
Newspapers	1	50 (19.3)	58 (22.4)	47 (18.1)	48 (18.5)	56 (21.6)	68.499	0.000
	2	24 (13.8)	23 (13.2)	53 (30.5)	30 (17.2)	44 (25.3)		
	3	23 (29.0)	17 (28.8)	0 (0.00)	19 (32.2)	0 (0.00)		
	4	3 (37.5)	2 (25.0)	0 (0.00)	3 (37.5)	0 (0.00)		
Newsletters/magazines	1	51 (15.3)	50 (15.0)	85 (25.4)	48 (14.4)	100 (29.9)	131.475	0.000
	2	10 (17.5)	16 (28.1)	15 (26.3)	16 (28.1)	0 (0.00)		
	3	25 (31.6)	29 (36.7)	0 (0.00)	25 (31.6)	0 (0.00)		
	4	14 (46.7)	5 (16.7)	0 (0.00)	11 (36.7)	0 (0.00)		
Brochures/pamphlets/ Posters	1	34 (19.8)	24 (14.0)	44 (25.6)	24 (14.0)	46 (26.7)	115.771	0.000
	2	18 (9.2)	40 (20.4)	56 (28.6)	38 (19.4)	44 (22.4)		
	3	35 (44.3)	13 (16.5)	0 (0.00)	21 (26.6)	10 (12.7)		
	4	13 (24.5)	23 (43.4)	0 (0.00)	17 (32.1)	0 (0.00)		
Books/journals/articles	1	67 (17.7)	66 (17.5)	85 (22.5)	60 (15.9)	100 (26.5)	90.420	0.000
	2	20 (33.3)	9 (15.0)	15 (25.0)	16 (26.7)	0 (0.00)		
	3	5 (12.2)	19 (46.3)	0 (0.00)	17 (41.5)	0 (0.00)		
	4	8 (38.1)	6 (18.6)	0 (0.00)	7 (33.3)	0 (0.00)		
Electronic media Agri. Information sources								
Television	1	7 (21.2)	15 (45.5)	0 (0.00)	8 (24.2)	3 (9.1)	118.901	0.000
	2	38 (32.5)	27 (23.1)	9 (7.7)	35 (29.9)	8 (6.8)		
	3	28 (10.6)	35 (13.3)	82 (31.2)	39 (14.8)	79 (30.0)		

	4	27 (31.0)	23 (26.4)	9 (10.3)	18 (20.7)	10 (11.5)		
Radio	1	45 (39.5)	28 (24.6)	6 (5.3)	24 (21.1)	11 (9.6)	86.500	0.000
	2	34 (13.7)	35 (14.1)	73 (29.3)	40 (16.1)	67 (26.9)		
	3	15 (13.6)	28 (25.5)	18 (16.4)	27 (24.5)	22 (20.0)		
	4	6 (22.2)	9 (33.3)	3 (11.1)	9 (33.3)	0 (0.00)		
New media Agri. Information sources								
Internet Browsing	1	39 (30.0)	21 (16.2)	44 (33.8)	20 (15.4)	6 (4.6)	103.532	0.000
	2	3 (7.3)	16 (39.0)	0 (0.00)	11 (26.8)	11 (26.8)		
	3	10 (11.9)	19 (22.6)	0 (0.00)	18 (21.4)	37 (44.0)		
	4	48 (19.6)	44 (18.0)	56 (22.9)	51 (20.8)	46 (18.8)		
Smart phones/WhatsApp	1	13 (10.1)	16 (12.4)	47 (36.4)	16 (12.4)	37 (28.7)	73.884	0.000
	2	7 (8.9)	3 (16.7)	0 (0.00)	8 (44.4)	0 (0.00)		
	3	13 (20.3)	18 (28.1)	0 (0.00)	16 (25.0)	17 (26.6)		
	4	67 (23.2)	63 (21.8)	53 (18.3)	60 (20.8)	46 (15.9)		
Agricultural Helpline	1	22 (8.8)	30 (12.0)	85 (34.1)	32 (12.9)	80 (32.1)	183.659	0.000
	2	29 (29.9)	15 (15.5)	12(12.4)	21 (21.6)	20 (20.6)		
	3	31 (27.4)	45 (39.8)	3 (2.7)	34 (30.1)	0 (0.00)		
	4	18 (43.9)	10 (24.4)	0 (0.00)	13 (31.7)	0 (0.00)		
Facebook	1	51 (24.9)	40 (19.5)	44 (21.5)	37 (18.0)	33 (16.1)	44.042	0.000
	2	11 (13.4)	14 (17.1)	12 (14.6)	17 (20.7)	28 (34.1)		
	3	32 (18.1)	29 (16.4)	44 (24.9)	36 (20.3)	36 (20.3)		
	4	6 (16.7)	17 (47.2)	0 (0.00)	10 (27.8)	3 (8.30)		
YouTube	1	31 (21.4)	18 (12.4)	59 (40.7)	19 (13.1)	18 (12.4)	115.629	0.000
	2	8 (16.3)	12 (24.5)	0 (0.00)	7 (14.3)	22 (44.9)		
	3	36 (16.7)	39 (18.1)	41 (19.1)	46 (21.4)	53 (24.7)		
	4	25 (27.5)	31 (34.1)	0 (0.00)	28 (30.8)	7 (7.7)		

Percentages are in parentheses; Used Scale: 1=not at all; 2= rarely; 3= occasionally; 4=frequently

The data presented in Table 1 shows that the agro-ecological zone-specific level of use of different agricultural information sources is statistically significant (p=0.000). In the Rice-Wheat agro-ecological zone, higher use of digital information sources (Smart phones/WhatsApp) was found. In the Mix cropping agro-ecological zone, relatively higher use of print media agricultural information sources was found. In the Cotton Mix agro-ecological zone, balanced use of different agricultural information sources was found. In the Maize-Wheat mix cropping agro-ecological zone, digital information communication sources were mostly used by the respondents. In the Rice agro-ecological zone, limited use of all the mass media agricultural information sources was found. The analysis indicated a significant association between the frequency of use of different mass media agricultural information sources by the respondents to seek updated agricultural information and agro-ecological zones of the Punjab, Pakistan. In case of print media, agricultural information sources like posters/brochures & pamphlets relatively high chi-square ($\chi 2$) value (115.771) indicates that significant variation in occasional and rare usage across all the agro-ecological zones.

From these findings, it is clear that there is a declining usage of print media agricultural information methods, and most of farmers shift towards the adoption of digital, dynamic, and more interactive agricultural information tools to update their agricultural-related knowledge. In this context, different agricultural mobile applications have been launched in Pakistan to empower farmers through digital initiatives. Top-ranked digital agricultural applications in Pakistan are Bakhabar Kissan, Ricult Pakistan, Kisan Zar Zameen, Kissan Bazaar, and Agri. Smart. These findings also indicate that there is a clear shift from traditional print media information sources to electronic and new media. These findings are in line with global trends as there is a shift from traditional media towards digital agricultural information and dissemination sources. It also highlights the need of aligning agricultural extension and advisory services with the growing demands and preferences of rural community (Aker, 2011; Zhai et al., 2018; Ali & Kumar, 2021). Using new media agricultural information sources (smartphones, internet-based applications, and social media etc.) by the farmers could significantly enhance the impact of agricultural information delivered to them (World Bank, 2017; FAO, 2019).

4.2 Typology of agricultural information received from varied mass media sources

Table 2 outlines the typology of agricultural-related information received from different mass media agricultural information sources. The respondents (50.0%-55.8%) predominantly used radio, television, and Internet browsing to get environment/weather-related information. Farmers of the targeted research areas mostly used smartphones/WhatsApp for seeking information related to plant protection practices (63.8%) and livestock management practices (16.0%). Facebook and YouTube were also being used as agricultural information sources for seeking information related to plant protection practices, as reported by 57.2% & 56.4% of respondents, respectively. Respondents rarely used Facebook and YouTube as an agricultural information source for getting information related to agricultural marketing and environment/weather.

Print media (Books/journals/articles, newspapers, and newsletters) information sources were mostly used for getting information related to agricultural marketing, environment/weather, and plant production practices as reported by 34.2%, 34.8% and 32.8% of respondents, respectively. It is important to mention here that newspapers, as a

print media agricultural information source, were used in a balanced pattern of agricultural marketing and environment/weather-related information. Respondents primarily used agricultural brochures, pamphlets/posters for seeking information related to post-harvest/processing/storage (31.6%) and plant protection-related practices (20.8%). The general trend of the data shows that farmers of the targeted research areas heavily rely on digital platforms for getting information regarding plant production and plant protection-related practices. In case of environment/weather-related information, respondents mostly rely on mass media information methods (radio, television and Internet Browsing). For seeking information related to the marketing of agricultural produce, respondents mostly rely on dealers of respective grain markets and newspapers, and newsletters. To get information concerning livestock management practices, respondents significantly depend upon the use of smartphones (WhatsApp).

Table 2

Typology of Agricultural-related information received from different Mass Media Agricultural Information Sources

Mass Media Information Sources	**Typology of Agricultural Information**					
	Plant Production	**Plant Protection**	**Marketing**	**Environment**	**Post-Harvest & Storage**	**Livestock Management**
Print media information sources						
Newspapers	51 (10.2)	47 (9.4)	171 (34.2)	174 (34.8)	40 (8.0)	17 (3.4)
Newsletters/Magazines	118 (23.6)	97 (19.4)	32 (6.4)	122 (24.4)	90 (18.0)	41 (8.2)
Brochures/pamphlets/posters	83 (16.6)	104 (20.8)	45 (9.0)	91 (18.2)	158 (31.6)	19 (3.8)
YouTube	56 (11.2)	282 (56.4)	23 (4.6)	58 (11.6)	48 (9.6)	33 (6.6)
Books/journals/articles	164 (32.8)	50 (10.0)	78 (15.6)	98 (19.6)	89 (17.8)	21 (4.2)
Electronic media information sources						
Television	51 (10.2)	71 (14.2)	17 (3.4)	279 (55.8)	43 (8.6)	39 (7.8)
Radio	58 (11.6)	75 (15.0)	28 (5.6)	263 (52.6)	49 (9.8)	27 (5.4)
New media information sources						
Internet Browsing	36 (7.2)	89 (17.8)	34 (6.8)	250 (50.0)	45 (9.0)	46 (9.2)
Smart phones/WhatsApp	21 (4.2)	319 (63.8)	7 (1.7)	19 (3.8)	54 (10.8)	80 (16.0)
Agricultural helpline	64 (12.8)	315 (63.0)	47 (9.4)	29 (5.8)	9 (1.8)	36 (7.2)
Facebook	92 (18.4)	286 (57.2)	30 (6.0)	19 (3.8)	57 (11.4)	16 (3.2)

Values in parentheses are percentages

4.3 Effectiveness of mass media as an agricultural information source

Table 3 presents the effectiveness of mass media as an information source for agricultural information among these farmers. The results show a substantial variation across zones. In the Rice-Wheat zone, 55.4% of respondents rated mass-media methods as "most effective," while in other zones, such as Rice and Maize-Wheat, no respondents reported the highest level of effectiveness. Increase in income: The Rice-Wheat zone again leads, with 47.3% of respondents rating the media as "most effective." Other zones like Cotton and Maize-Wheat had no respondents rating the media as "most effective." Good source of latest agricultural information/innovation: In the Rice-Wheat zone, 67.3% of respondents identified mass media as the "most effective" source of information. In comparison, other zones, such as Cotton, had only 4.1% of respondents considering it most effective. Mass media's ability to save time and money was perceived most effectively by Rice-Wheat respondents (80.0%), while Maize-Wheat respondents rated it less effective. Easy access to microcredit & other farm inputs: The Rice-Wheat zone stands out, with 52.8% of respondents rating media as "moderately effective" for easy access to farm inputs. The Maize-Wheat zone had no respondents rating media highly in this regard.

The Rice-Wheat zone had 50.6% of respondents rating mass media as the "most effective" for improving linkages with stakeholders, while the Cotton and Maize-Wheat zones showed lower effectiveness ratings. Improved linkages with farmers: The Rice-Wheat zone again had a high percentage (40.2%) rating mass media as "most effective" for improving linkages with farmers, while other zones, such as Cotton and Maize-Wheat, had lower percentages. Mass media's role in improving farm knowledge was rated "most effective" by 39.3% of respondents in the Rice-Wheat zone, while other zones, such as Cotton, showed lower percentages. In the Rice-Wheat zone, 44.2% of respondents rated media as "most effective" in improving participation in community development, while Maize-Wheat had only 7.1%. The Maize-Wheat zone demonstrated the highest percentage (41.4%) rating media as effective for improving access to NGOs. In contrast, the Rice-Wheat zone had 44.8% of respondents considering it "most effective." The Rice-Wheat zone had the highest percentage (24.7%) rating mass media as "most effective" in improving adoption rates. Other zones, such as Cotton and Maize-Wheat, showed moderate to lower ratings.

Table 3

Effectiveness of mass-media information sources across Agro-Ecological zones

Effectiveness parameters	Scale	Agro-ecological Zone					Chi-Square	p-Value
		Rice-Wheat	Mix Cropping	Rice	Cotton	Maize-Wheat		
Increase in farm yield	1	19 (21.8)	40 (46.0)	0 (0.0)	28 (32.2)	0 (0.0)	162.681	0.000
	2	16 (11.5)	25 (18.0)	35 (25.2)	25 (18.0)	38 (27.3)		
	3	29 (13.9)	28 (13.4)	65 (31.1)	37 (17.7)	50 (23.9)		
	4	36 (55.4)	7 (10.8)	0 (0.0)	10 (15.4)	12 (18.5)		
Increase in income	1	18 (36.7)	16 (32.7)	0 (0.0)	15 (30.6)	0 (0.0)	126.491	0.000
	2	10 (6.8)	38 (25.7)	35 (23.6)	27 (18.2)	38 (25.7)		
	3	28 (13.3)	33 (15.7)	65 (31.0)	40 (19.0)	44 (21.0)		
	4	44 (47.3)	13 (14.0)	0 (0.0)	18 (19.4)	18 (19.4)		
Good source of the latest Agricultural information /innovation	1	23 (39.0)	19 (32.2)	0 (0.0)	17 (28.8)	0 (0.0)	146.727	0.000
	2	16 (10.0)	39 (24.4)	35 (21.9)	29 (18.1)	41 (25.6)		
	3	28 (12.1)	38 (16.4)	65 (28.0)	44 (19.0)	57 (24.6)		
	4	33 (67.3)	4 (8.2)	0 (0.0)	10 (20.4)	2 (4.1)		
Save money and time	1	21 (19.1)	53 (48.9)	0 (0.0)	36 (32.7)	0 (0.0)	224.663	0.000
	2	24 (12.5)	19 (9.9)	59 (30.7)	28 (14.6)	62 (32.3)		
	3	27 (16.6)	27 (16.6)	41 (25.2)	32 (19.6)	36 (22.1)		
	4	28 (80.0)	1 (2.9)	0 (0.0)	4 (11.4)	2 (5.7)		
Easy access to microcredit & Other farm inputs	1	36 (24.5)	51 (34.7)	9 (6.1)	41 (27.9)	10 (6.8)	158.979	0.000
	2	30 (10.3)	41 (14.0)	91 (31.2)	45 (15.4)	85 (29.1)		
	3	19 (52.8)	5 (13.9)	0 (0.0)	9 (25.0)	3 (8.3)		
	4	15 (60.0)	3 (12.0)	0 (0.0)	5 (20.0)	2 (8.0)		
Better linkages with stakeholders	1	10 (21.7)	23 (50.0)	0 (0.0)	13 (28.3)	0 (0.0)	181.782	0.000
	2	24 (8.1)	51 (17.2)	85 (28.7)	46 (15.5)	90 (30.4)		
	3	21 (30.4)	7 (10.1)	15 (21.7)	16 (23.1)	10 (14.5)		
	4	45 (50.6)	19 (21.3)	0 (0.0)	25 (28.1)	0 (0.0)		
Improved linkages with farmers	1	10 (37.5)	10 (37.5)	0 (0.0)	8 (28.6)	0 (0.0)	113.318	0.000
	2	14 (10.1)	25 (18.0)	35 (25.2)	24 (17.3)	41 (29.5)		
	3	39 (16.2)	39 (16.2)	65 (27.0)	39 (16.2)	59 (24.5)		
	4	37 (40.2)	26 (28.3)	0 (0.0)	29 (31.5)	0 (0.0)		
Improve farm knowledge level	1	5 (35.7)	6 (42.9)	0 (0.0)	3 (21.4)	0 (0.0)	61.432	0.000
	2	20 (12.3)	33 (20.4)	38 (23.5)	29 (17.9)	42 (25.9)		
	3	27 (13.4)	44 (21.8)	51 (25.2)	41 (20.3)	39 (19.3)		
	4	48 (39.3)	17 (13.9)	11 (9.0)	27 (22.1)	19 (15.6)		
Improve participation level in community development	1	12 (20.3)	10 (16.9)	15 (25.4)	11 (18.6)	11 (18.6)	79.323	0.000
	2	12 (8.5)	27 (19.1)	38 (27.0)	21 (14.9)	43 (30.5)		
	3	26 (13.9)	45 (24.1)	36 (19.3)	42 (22.5)	38 (20.3)		
	4	50 (44.2)	18 (15.9)	11 (9.7)	26 (23.0)	8 (7.1)		
Improve access to NGOs	1	24 (10.6)	24 (10.6)	56 (24.7)	29 (12.8)	94 (41.4)	194.069	0.000
	2	12 (13.3)	22 (24.4)	29 (32.2)	21 (23.3)	6 (6.7)		
	3	25 (26.0)	33 (34.4)	12 (12.5)	26 (27.1)	0 (0.0)		
	4	39 (44.8)	21 (24.1)	3 (3.4)	24 (27.6)	0 (0.0)		
Improve adoption rate of innovative agricultural technologies	1	4 (10.3)	21 (53.8)	0 (0.0)	14 (35.9)	0 (0.0)	74.062	0.000
	2	28 (16.8)	32 (18.6)	44 (25.6)	35 (20.3)	33 (19.2)		
	3	31 (22.3)	14 (10.1)	24 (17.3)	24 (17.3)	46 (33.1)		
	4	37 (24.7)	33 (22.0)	32 (21.3)	27 (28.0)	21 (14.0)		
Enhance confidence level	1	6 (40.6)	3 (20.0)	0 (0.0)	6 (40.6)	0 (0.0)	49.729	0.000
	2	15 (11.5)	21 (16.0)	44 (33.6)	20 (15.3)	31 (23.7)		
	3	28 (20.1)	33 (23.7)	12 (8.6)	29 (20.9)	37 (26.6)		
	4	51 (23.7)	43 (20.0)	44 (20.5)	45 (20.9)	32 (14.9)		
	1	3 (75.0)	0 (0.0)	0 (0.0)	1 (25.0)	0 (0.0)	28.774	0.004
	2	18 (11.4)	30 (19.0)	38 (24.1)	29 (18.4)	43 (27.2)		

Improve knowledge about Agricultural marketing	3	22 (19.0)	29 (25.0)	18 (15.5)	25 (21.6)	22 (19.0)		
	4	57 (25.7)	41 (18.5)	44 (19.8)	45 (20.3)	35 (15.8)		
Improve decision-making capacity	1	6 (8.5)	28 (39.4)	12 (16.9)	18 (25.4)	7 (9.9)	79.800	0.000
	2	14 (10.8)	18 (13.8)	38 (29.2)	17 (13.1)	43 (33.1)		
	3	16 (14.5)	26 (23.6)	18 (16.4)	28 (25.5)	22 (20.0)		
	4	64 (33.9)	28 (14.8)	32 (16.9)	37 (19.6)	28 (14.8)		
Improve the ability to mitigate Agricultural risks	1	9 (40.9)	6 (27.3)	0 (0.0)	7 (31.6)	0 (0.0)	64.228	0.000
	2	15 (10.1)	19 (12.8)	44 (29.5)	20 (13.4)	51 (32.4)		
	3	26 (26.3)	23 (23.2)	12 (12.1)	24 (24.2)	14 (14.1)		
	4	50 (21.7)	52 (22.6)	44 (19.1)	49 (21.3)	35 (15.2)		

Percentages are in parentheses *Scale: 1=not effective; 2= less effective; 3= moderate effective; 4=most effective*

The mass media's impact on enhancing farmers' confidence was rated as "most effective" by 23.7% of Rice-Wheat respondents. Other zones, like Maize-Wheat, had varying levels of effectiveness. The Rice-Wheat zone rated mass media as highly effective (75.0%), while other zones, such as Cotton, rated it lower. In the Rice-Wheat zone, 33.9% of respondents rated media as "most effective" for improving decision-making, while Maize-Wheat had a more neutral distribution. Improve ability to mitigate Agricultural risks: The Rice-Wheat zone demonstrated 21.7% of respondents rating media as "most effective" in risk mitigation, while the Maize-Wheat zone showed lower levels. This has been concluded that χ^2 test and p-values confirms a significant difference in the perceived effectiveness of media across agro-ecological zones. This indicates that the role of mass media in enhancing agricultural practices varies significantly by region, with the Rice-Wheat zone generally perceiving it as the most effective tool. The results suggest the need for tailored media strategies to address the specific agricultural challenges of each zone.

Table 4

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.861[a]	.742	.740	.30546
a. Predictors: (Constant), Time of using mass media, Usefulness of Information Received from Mass Media, Relevancy Usefulness of Information Received from Mass Media & Frequency of using mass media			

ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	132.731	4	33.183	355.628	.000[b]
Residual	46.187	495	.093		
Total	178.918	499			
a. Dependent Variable: Effectiveness of mass media information sources					

b. Predictors: (Constant), Time of using mass media, Usefulness of Information Received from Mass Media, Relevancy Usefulness of Information Received from Mass Media & Frequency of using mass media					
Coefficients[a]					
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	.064	.088		.728	.467
Usefulness of Information Received from Mass Media	.167	.026	.155	6.492	.000
Relevancy of Information Received from Mass Media	.110	.026	.100	4.285	.000
Frequency of using mass media	.637	.022	.714	28.580	.000
Time of using mass media	.127	.015	.210	8.712	.000
a. Dependent Variable: Effectiveness of mass media information sources					

The small difference between R Square and Adjusted R Square indicates that the Independent Variables/predictors (time, usefulness, relevancy, and frequency of using mass media) are relevant and there is no significant over-fitting. This demonstrates a strong positive relationship between the predictors (independent variables) and the dependent variable, explaining 74.2% of the variance and indicating a good fit to the data. Independent Variables/predictors (time, usefulness, relevancy, and frequency of using mass media) collectively have a significant impact on the dependent variable (Effectiveness of Mass Media Information Sources). The data shows that all the independent variables of the study showed statistically significant positive influence on the effectiveness of mass media information sources ($R^2 = 0.742$, $p < 0.001$). Among these variables, "frequency of use" emerged as the strongest predictor ($\beta = 0.714$). This indicates that frequent use of mass media is used as an agricultural information source, more would be its perceived effectiveness. These findings align with the previous research studies presented by Mittal & Mehar, 2016 and Aker, 2011 and conclude that regular exposure to the information source enhanced the level of information retention. The usefulness ($\beta = 0.155$) and relevancy ($\beta = 0.100$) of information received from different mass media sources also positively affected the effectiveness. This supported the notion presented by Glendenning et al., (2010) that the quality of the contents and their alignment with the actual needs of the farming community plays prominent role in their decision-making process. This highlighted the significance of contents that must be in line with needs of targeted community and frequency of usage of mass media information sources. The frequency and time of use of mass media as agricultural information source was also described by Ali, J., & Kumar, S. (2011) and Qamar, M. (2005). The usefulness of information received from different mass media information sources was also highlighted by Meitei, L. S., & Devi, T. P. (2009). They concluded that

the usefulness of information is the key determinant of its impact on farm-related decisions. On similar lines, Zijp, W. (1994) highlighted that effectiveness would be more if information received would be practical, in time and relevant to the needs of farmers. The same was also discussed by Kizito, J., Donovan, K., & Maxon, M. (2010) and Chapman, R., & Slaymaker, T. (2002) while concluding that the relevancy of farm-related information to the local farming community greatly affects how they perceive and use mass media information. The interaction between frequency of use, relevancy of information received, and its usefulness is very much critical in enhancing the effectiveness of mass media information sources. This also aligns with the findings reported by Rivera, W. M., & Qamar, M. K. (2003).

5 CONCLUSIONS, IMPLICATIONS, AND FUTURE RESEARCH DIRECTIONS

Findings concluded that farmers across different agro-ecological zones showed significant variation in the use of different mass media information sources. This also concluded that there is significant variation in the frequency of usage of different mass media agricultural information sources across agro-ecological zones. This has been concluded that different mass media information sources serve diverse information needs of farmers. This also concluded that mass media shows significant effectiveness in various aspects of agricultural development, particularly in increasing farm yield, income, and knowledge, improving farmer confidence, and enhancing linkages with other stakeholders. The role of mass media in enhancing agricultural practices varies significantly by agro-ecological regions. The regression model significantly predicted the effectiveness of mass media information sources ($R^2 = 0.742$, $p < 0.001$), with frequency of use, usefulness, relevancy of information received, and time of usage making statistically significant positive predictors.

The significant variations in mass media usage and effectiveness across different agro-ecological zones highlight the need for tailored communication strategies. Instead of a one-size-fits-all approach, agricultural extension services and policymakers should develop region-specific media campaigns that consider the unique information needs and media consumption habits of farmers in each zone. This localized approach can ensure that agricultural information, whether related to new farming techniques, market prices, or climate-resilient practices, reaches the intended audience more effectively, thereby

maximizing its impact on farm productivity and farmer livelihoods. Furthermore, the findings underscore the importance of optimizing the frequency, usefulness, relevancy, and timing of information dissemination through mass media. Since these factors were identified as significant positive predictors of effectiveness, efforts should focus on enhancing the quality and timeliness of content. This could involve collaborating with local agricultural experts to ensure relevancy, utilizing diverse media formats to cater to varied preferences, and strategically scheduling broadcasts or publications to align with critical farming seasons or decision-making periods. Such targeted improvements can significantly amplify the role of mass media in fostering agricultural development, leading to increased yields, income, and overall farmer empowerment.

Ultimately, these implications suggest a strategic shift towards more nuanced and data-driven approaches to agricultural communication. By understanding and responding to the specific dynamics of mass media use within different agro-ecological contexts, stakeholders can leverage these powerful tools to build farmer confidence, enhance their knowledge base, and strengthen their linkages with essential agricultural value chain actors. This targeted intervention will be crucial in achieving sustainable agricultural growth and improving the resilience of farming communities.

Future research should investigate the effectiveness of specific mass media channels within various agro-ecological zones to identify optimal platforms for disseminating agricultural information, considering the diverse information needs and media consumption habits of farmers. In addition, studies could explore the direct impact of highly customized and timely agricultural content on farmer adoption rates of new practices, given the importance of relevancy and usefulness as predictors of effectiveness. Further research is also warranted on the economic returns and long-term behavioral changes resulting from targeted mass media interventions, alongside an analysis of barriers preventing farmers from fully utilizing these information sources, to inform more effective and sustainable agricultural communication strategies.

6 RECOMMENDATIONS

Based on the findings of the study following recommendations are hereby proposed to enhance the level of effectiveness of agricultural knowledge and information dissemination through mass media sources:

- Improve digital infrastructure in rural localities to facilitate wide access to digital agricultural information, especially in remote agro-ecological zones
- Contents of agricultural-related information must be in line with the real needs of the farming community and should be zone-specific by translating local/regional language
- Agricultural programs on digital/news, electronic, and print media should be more frequent, covering a broader range of issues and priorities of the farming community
- Capacity-building initiatives should be taken to help small-scale farmers having limited farming experience regarding the effective use of mass media to improve their decision-making capacity
- Audio-visual aids should be employed, especially for farmers with a low literacy level
- Regular and periodic assessments should be conducted to evaluate the effectiveness and impact of mass media agricultural information sources
- An integrated strategy should be prepared combining all the mass media information sources and face-to-face contact to ensure that consistent farm related information is in the in the reach of diverse farming communities

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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