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Data-Driven Insights for Agricultural Extension Services in Rajasthan: A Study of Kisan Call Center Queries

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ABSTRACT

Adopting a demand-driven approach in an ever-evolving agricultural domain is imperative for the effectiveness of agricultural extension services, particularly in the state of Rajasthan, India. The paper comprehensively analyses the vast dataset comprising over four million farmer query calls to the Kisan Call Center in Rajasthan from January 2009 to August 2023. These meticulously preprocessed call records serve as a crucial bridge between the agricultural community and support services, providing invaluable insights into the challenges and needs of Rajasthan's farmers. Our analysis examines temporal trends in farmer query calls, revealing year-wise and month-to-month insights, including peak call activity periods. The district-wise analysis aids targeted interventions. Understanding call distribution across diverse landscapes. Categorising calls by crop and query type offers insights into distinct farmer challenges, informing tailored policies and support programs. In conclusion, this research underscores the paramount importance of harnessing data-driven insights to enhance agricultural support systems in Rajasthan. By doing so, we can ensure the long-term sustainability and prosperity of the farming community, thus contributing to the overall well-being of the state's agriculture sector. The research is useful for informing evidence-based policy decisions and tailored support services to enhance agricultural productivity and sustainability in Rajasthan.

INTRODUCTION

Agriculture has been the bedrock of India's economy, providing sustenance to a significant portion of its populace and serving as a cornerstone of economic advancement (Choudhary et al., 2014). In Rajasthan, an analogous agricultural backdrop underscores the sector's prominence. Furthermore, adaptation and responsiveness in support systems are paramount to ensuring the continued prosperity of this crucial sector (Shaloo et al., 2022). Kisan Call Centers (KCC) in India serve as vital lifelines for the agricultural community, offering real-time assistance and information through phone calls. These centers are a part of the government's commitment to supporting farmers by providing a toll-free helpline (1800-180-1551) accessible across the country (Godara & Toshniwal, 2022). They play a critical role in disseminating knowledge, resolving concerns, and enhancing the overall sustainability of Indian agriculture (Godara & Toshniwal, 2020). In Rajasthan, the KCC assumes an equally innovative and essential role as in other states. As an interface connecting farmers with agricultural support services, the KCC has become a cornerstone of agricultural assistance (Godara et al., 2023). It offers a platform for farmers to seek solutions and guidance for their pressing

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agricultural issues (Godara et al., 2022). Rajasthan's KCC, operated by the state government, has collected and managed a vast dataset of farmer query calls encompassing various agricultural topics. Our focus is on the dataset from 2009 to the present, comprising an impressive total of query call logs. These logs have undergone meticulous preprocessing to ensure accuracy and reliability, providing a unique opportunity to gain insights into the evolving challenges and needs of the state's agricultural community. The objectives of this study encompass; exploring the temporal trends in farmer query calls, month-wise insights into the dataset unveil farmer query seasonality, district-wise analysis to map the geographical distribution of query calls, and categorization of calls based on crop and query types to gain a granular perspective on farmers' specific challenges.

The findings aim to inform evidence-based policy decisions, empower agricultural experts, and ultimately benefit the farmers of Rajasthan by effectively addressing their evolving needs. By doing so, we endeavor to ensure that Rajasthan's agriculture continues flourishing as a resilient sector capable of meeting the state's food security and economic development demands. The research study on the Rajasthan KCC dataset introduces a novel perspective on the state's agricultural landscape, shedding light on the unique challenges and needs of farmers in Rajasthan. By exploring temporal trends, seasonality, and geographic distribution of query calls, we offer valuable insights that can inform tailored support initiatives and policy decisions. Categorizing calls by crop and query type adds granularity, enabling the development of targeted solutions for distinct agricultural issues. Ultimately, this research has the potential to enhance the effectiveness of agricultural support systems and ensure the long-term prosperity of Rajasthan's farming community.

METHODOLOGY

The research methodology deployed in this study represents a meticulously structured framework designed to thoroughly analyze the dataset of farmer query calls from the Kisan Call Center (KCC) in Rajasthan, India. The outlined steps encapsulate a systematic approach encompassing eight methodological steps namely data collection, data preprocessing, temporal analysis, geospatial analysis, categorical analysis, data visualization, interpretation & inference and policy recommendations as detailed.

The primary data source was the KCC dataset, obtained from the KCC-CHAKSHU portal (https://kcc-chakshu.icar.gov.in/). This dataset encompasses vital information, including call date and time, caller location up to the district level, specific crops discussed, query nature, and pertinent details conveyed during calls. Data preprocessing was pivotal to ensure the dataset's quality and consistency. This involved a comprehensive data cleansing process, addressing missing values, duplicates, and outliers. Furthermore, the standardization of date formats was performed to ensure uniformity, and the data was meticulously categorized into distinct crop and query types, thus facilitating a more refined analysis. The data was also aggregated to create subsets for various timeframes (e.g., year-wise and month-wise) and spatial scales (e.g., district-wise). The calculation of the total number of query calls for each year and month to gain insights into year- and month-wise trends was done. This analytical approach allowed to uncover how the volume of calls has evolved over the years and pinpoint peak months of call activity. Further, an in-depth geospatial analysis scrutinized the distribution of query calls across different districts. This was achieved by calculating each district's total number of calls, enabling to identify regions with higher call volumes. Such insights are pivotal for targeted resource allocation and specific support services. In categorical analysis, categorizing calls into different crop and query types and analyzing the number of calls within each category was taken up. This analytical facet offered significant insights into the specific challenges encountered by farmers concerning different crops and query types. Visual aids, such as charts and graphs, were employed to represent the findings visually. These visuals enhanced the comprehensibility and interpretability of the results for the audience. The results derived from the data analysis were subjected to interpretation to yield meaningful conclusions. This interpretation encompassed a broad spectrum of insights into temporal, geographical, and categorical trends within farmer query calls. Finally, as a foundation for formulating policy recommendations and interventions that could effectively address the identified issues were derived. The research, therefore, provided a valuable basis for evidence-based decision-making within the domains of agricultural policy and support services.

This research followed an organized and structured approach encompassing various stages, from data collection and preprocessing to comprehensive analysis and interpretation. Employing mathematical calculations and data visualization provided invaluable insights into the dynamics of farmer query calls in Rajasthan, laying the groundwork for evidence-based decision-making in agricultural policy and support services.

RESULTS

The year-wise analysis of farmer query calls in Rajasthan, India, from 2009 to 2023 reveals several intriguing trends and fluctuations (Figure 1). Notably, from 2009 onward, there is a consistent upswing in the number of query calls. This upturn in call volumes reflects the evolving challenges in the agricultural sector, indicating that farmers seek more assistance and information. The substantial peak in 2019 is an intriguing anomaly, possibly linked to specific agricultural issues, changes in government policies, or other external factors. After 2019, there is a decrement in the number of query calls. Several factors can contribute to the fluctuations in call volumes, including external variables such as the COVID-19 pandemic, information and communication technology advancements, weather phenomena during the period, and economic conditions.

Figure 2 presents a monthly breakdown of query calls from the Kisan Call Center (KCC) in Rajasthan, India. The data shows that the highest number of query calls occurred in July, with a total of 559,785 calls, followed closely by August, with 572,458 calls. These two months represent the peak of farmer engagement with the KCC. This pattern aligns with the agricultural calendar, as these months typically correspond to the monsoon season, a crucial crop cultivation and management period. The months from June to September, covering the monsoon season, collectively witness the

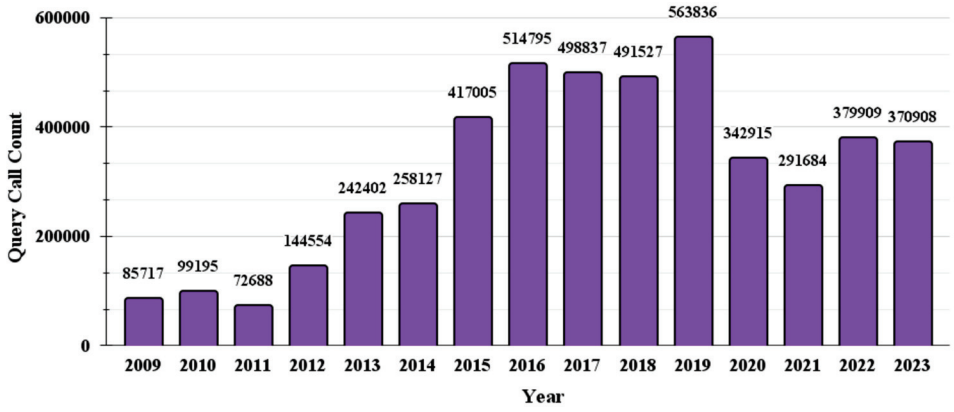

Figure 1. Year wise query counts of farmer calls from 2009 to 2023 in Rajasthan, India

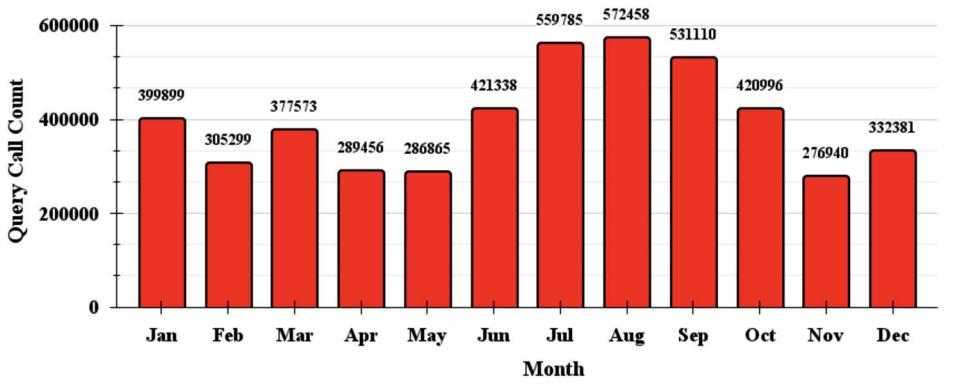

Figure 2. Month-wise analysis of query counts of farmer calls from 2009 to 2023 in Rajasthan, India

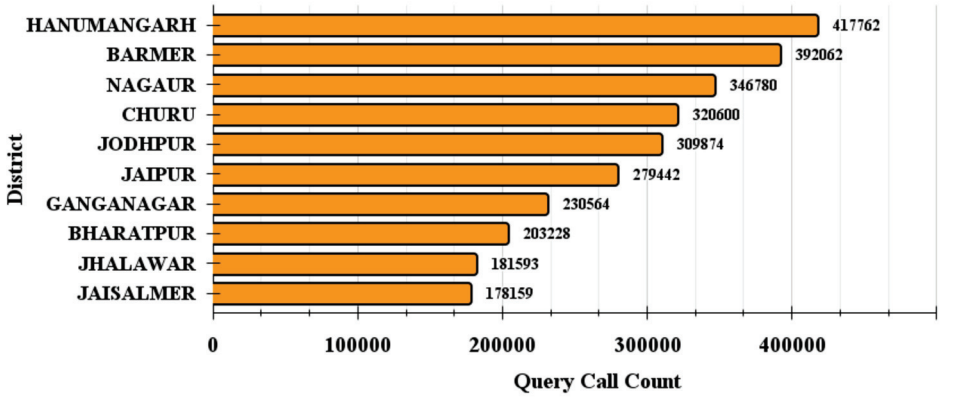

Figure 3. District-wise analysis (top ten districts) of query counts of farmer calls in Rajasthan, India

highest call volumes. This indicates the heightened demand for agricultural information and support during the critical phases of sowing, crop growth, and pest management. In contrast, the call volumes drop significantly from November to February. The lowest number of calls occurred in November, with 276,940 calls. These months align with the post-monsoon and winter seasons when agricultural activities, especially crop cultivation, are relatively less intensive. Call volumes start to rise again in March as farmers prepare for the upcoming harvest and address any crop-related issues. Government policies, crop cycles, and local weather conditions may also influence the fluctuations in call volumes. For example, specific government schemes, pest outbreaks, or weather events can trigger increased call activity during certain months.

Figure 3 provides a district-wise breakdown of the top ten districts with the greatest number of query calls in Rajasthan, India. The district of Hanumangarh received the highest number of query calls, with a total of 417,762 calls, making it the district with the most significant farmer engagement with the KCC. Barmer and Nagaur follow closely with 392,062 and 346,780 calls, respectively. These districts stand out for their high call volumes, indicating a strong demand for agricultural assistance and information. Churu, Jodhpur, and Jaipur also registered substantial call volumes, indicating that these districts need agricultural support services. These districts form a geographical cluster in the northwest and central parts of the state. The data reflects regional variations in the agricultural landscape of Rajasthan. Government policies,

weather events, or other factors may also influence the fluctuations in call volumes. Specific government schemes or weather-related challenges can trigger increased call activity in certain districts during particular periods. This data highlights the diversity of agricultural needs and challenges across Rajasthan's districts. It underscores the importance of tailoring support and interventions to address the specific requirements of each district. Effective resource allocation and targeted assistance in districts with high call volumes are crucial for enhancing agricultural productivity and sustainability in Rajasthan.

Figure 4 presents the top crops farmers ask questions about in the Rajasthan state. The figure shows that Wheat, Mustard, and Pearl Millet emerge as the top three crops for which farmers sought assistance, with 243,653, 185,226, and 170,221 calls, respectively. These crops play a vital role in the state's agriculture, reflecting the significant reliance on these staple crops. The data illustrates the diversity of crops cultivated in Rajasthan, with a wide range of crops receiving varying levels of attention. For example, Guar, Cotton, and Moong beans are significant crops for which farmers sought assistance, with 159,803, 154,963, and 123,144 calls, respectively. Certain crops like Cumin, Onion, and chillies also received considerable attention, indicating the need for specific guidance on these crops, which often have unique cultivation requirements. The call volumes for crops like Tomato, Citrus, Soybean, Lemon, Pomegranate, Garlic, Brinjal, and Bhindi reveal that these crops are of importance to farmers in Rajasthan. Understanding the challenges and queries related to these crops is essential for enhancing agricultural practices and crop yields. The data suggests that farmers seek support for various crops, indicating a desire to diversify their agricultural activities and increase income through multiple crop options (Yalakonda et al., 2023)

Figure 5 provides an insight into the types of queries received by the Kisan Call Center (KCC) in Rajasthan, India, categorized by query type. The figure shows that the Weather-related queries received the highest count, with 2,071,869 calls. This suggests that farmers in Rajasthan are highly concerned about weather conditions and their impact on agricultural practices. Weather-related questions may encompass issues like rainfall, drought, temperature, and weather forecasts, all of which are critical for crop planning and management. The second most common query type is related to plant protection, with 848,185 calls. These queries may involve pest and disease management concerns, including advice on pesticide

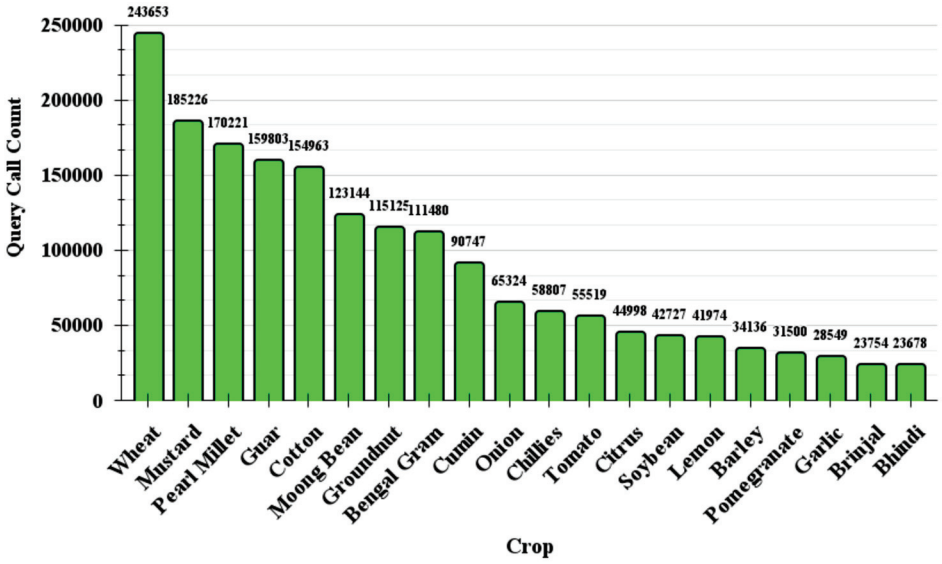

Figure 4. Farmers' agricultural priorities and concerns in top crops of Rajasthan, India

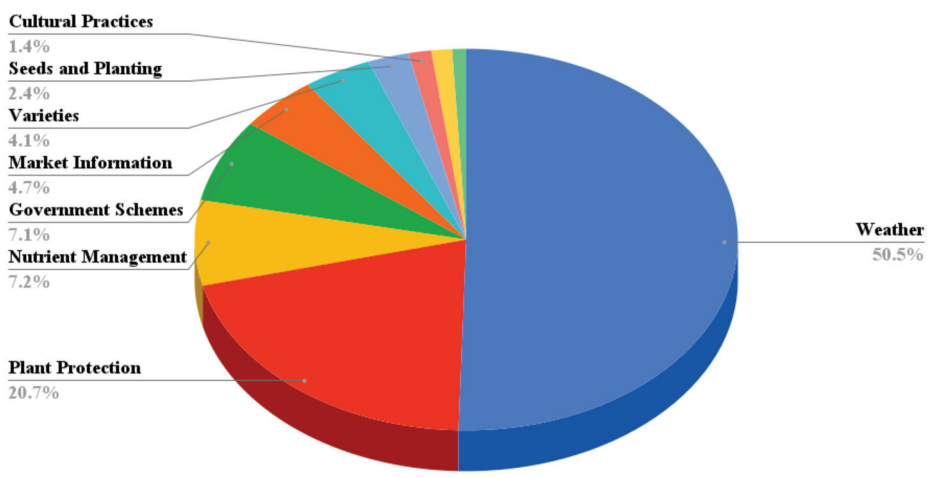

Figure 5. Query-type wise analysis of farmer calls from 2009 to 2023 in Rajasthan, India

use and integrated pest management strategies. Nutrient management queries are the third most frequent, with 295,946 calls. These inquiries likely pertain to using fertilizers and nutrients to optimize crop growth and health. Questions regarding government agricultural schemes received many calls, with 289,892 inquiries. Farmers are likely seeking information and assistance regarding various government programs, subsidies, and support available to them. The data reflects 192,498 calls related to market information. Farmers may inquire about market prices, demand, and strategies for selling their produce.

Queries about crop varieties and their suitability for different regions and seasons resulted in 166,746 calls. This indicates that farmers are interested in optimising their crop choices. Questions about seeds and planting material received 100,173 calls, suggesting that farmers seek guidance on selecting the right seeds for their crops. Cultural practices, including information about crop cultivation techniques, received 56,075 calls. Farmers are likely looking for advice on best practices for crop cultivation. Weed management queries received 50,402 calls, reflecting concerns about controlling weed infestations that can hinder crop growth. Queries related to soil testing resulted in 34,467 calls, indicating an interest in understanding soil health and nutrient content.

DISCUSSION

The analysis provides a comprehensive overview of query call data from the Kisan Call Center in Rajasthan, India. The month-wise analysis reveals the seasonality of farmer engagement, with peak activity during the monsoon season necessitating timely support and advisory services. District-wise data highlights the varying agricultural challenges across regions, emphasising the need for localised assistance and resource allocation. Crop-wise analyses demonstrate the diverse agricultural landscape in Rajasthan, indicating the demand for tailored support services for staple crops and specialised guidance for niche crops. Query-type data underscores the diverse needs of farmers, highlighting the significance of weather information, plant protection, nutrient management, and government scheme awareness in agricultural decision-making (Kumar et al., 2015). Policymakers can utilise these insights to refine agricultural support systems and provide targeted assistance, enhancing the sustainability and prosperity of Rajasthan's farming community (Meena et al., 2022).

Based on the month-wise query call data from the Kisan Call Center in Rajasthan, several policy recommendations can be made to enhance agricultural support services in the state. During peak call months, particularly in July and August, authorities should bolster resources and staff at the call centre to ensure timely responses and assistance. The data also underscores the need for targeted advisory services, especially during the monsoon season, addressing issues such as crop diseases and pest management. Furthermore, initiatives to encourage crop diversification and promote resilience in the post-monsoon months, when call volumes are lower, can help farmers enhance their overall livelihoods (Vijay et al., 2018). Lastly, improving access to timely weather information and advisory services is essential to support farmer decision-making throughout the year (Godara et al., 2023). Based on the district-wise query call data from the Kisan Call Center in Rajasthan, several policy recommendations can be made to strengthen agricultural support in the state. Districts with high call volumes, like Hanumangarh and Barmer, should receive targeted assistance and resources to address specific regional challenges. Tailored advisory services and training programs should be developed to address each district's unique agricultural practices and conditions (Godara et al., 2022). Emphasizing local crop diversification initiatives and strengthening local agricultural cooperatives can promote economic sustainability. Additionally, investment in digital platforms and mobile applications for remote areas can improve access to agricultural information and support services, particularly in districts with lower call volumes (Singh et al., 2023; Nair et al., 2023). Based on the crop-wise query call data from the Kisan Call Center in Rajasthan, policy recommendations should address the diversity of agricultural concerns. High call volumes for crops like Wheat, Mustard, and Pearl Millet underscore the importance of sustaining support systems for staple crops. To maximise agricultural productivity, there's a need for specialized advisory services and training programs for horticultural crops like Cumin, Onion, and Chillies. Encouraging crop diversification through incentives and market linkages can boost farmers' incomes (Kar et al., 2020). Additionally, research and extension services tailored to specific crops should be developed to improve yields, quality, and overall agricultural sustainability (Kumar et al., 2015; Niranjan et al., 2023).

Based on the query type data from the Kisan Call Center in Rajasthan, policy recommendations should focus on enhancing agricultural information dissemination and support. Weather-related queries receive the highest attention, highlighting the critical importance of strengthening meteorological services and providing farmers with real-time weather data (Yashavanth et al., 2022). Plant protection and nutrient management queries indicate a need for tailored guidance on pest and disease management and efficient fertilizer use. Government schemes and market information queries underscore the importance of simplifying access to agricultural subsidies and improving market linkages for farmers (Maruthi, 2017). Furthermore, promoting awareness and training in these areas can empower farmers to make informed decisions and enhance agricultural productivity.

CONCLUSION

The seasonality of query calls, as evidenced by our month-wise analysis, underscores the urgency of offering timely support during peak agricultural periods. The district-wise breakdown has highlighted farmers' diverse challenges, emphasizing the need for localized, region-specific interventions. Further insights from crop-wise data reveal the array of crops cultivated in Rajasthan, underlining the importance of tailored support systems for both staple and niche crops. Additionally, the query-type data underscores the multifaceted demands of farmers, advocating for enhanced weather information, plant protection, nutrient management, and government scheme awareness. Our research is a valuable foundation for evidence-based policymaking, resource allocation, and support service development to foster sustainability and prosperity in Rajasthan's agriculture. By addressing the specific and dynamic needs of the farming community, we can pave the

way for a resilient agricultural sector capable of meeting the state's food security and economic development demands.

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