Decoding agricultural needs: An in-depth analysis of farmer queries in Punjab's Kisan call center

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Summary

Adopting a demand-driven approach in a rapidly changing agricultural sector is crucial for extension services to remain relevant and impactful in India. In this direction, the article presents a comprehensive analysis of over two million farmer query calls made to the Kisan Call Center in Punjab, India, from January 2009 to August 2023. These preprocessed call logs are a vital link between farmers and agricultural support services, providing valuable insights into the agricultural community's challenges and requirements. Our analysis commences by examining temporal trends in farmer query calls, offering year-wise statistics that unveil the evolution of call volumes over time. Furthermore, we delve into the dataset to provide month-wise insights, shedding light on the seasonality of these queries. By identifying peak months of call activity, we can pinpoint critical periods when farmers require assistance the most. Furthermore, district-wise analysis aids in mapping the geographical distribution of these calls, enabling policymakers and agricultural authorities to target specific regions with tailored interventions. Our breakdown by crop category and query type also provides a granular perspective on farmers' concerns. By categorising calls based on the crops and query types, we gain valuable insights into the distinct challenges faced by Punjab's farmers. This information can guide the development of agricultural policies, extension services, and support programs tailored to address the unique needs of different crop categories and query types. Ultimately, this study underscores the significance of harnessing data-driven insights to enhance agricultural support systems, ensuring India's farming community's long-term sustainability and prosperity.

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Introduction

Agriculture has been the backbone of India's economy for centuries, providing livelihoods to a significant portion of the population and serving as a critical driver of economic growth (Louhar et al. 2020). In Punjab, often called the "Granary of India," agriculture has played an especially pivotal role in shaping the region's socio-economic landscape. However, the challenges farmers face in Punjab have evolved, necessitating adaptive and responsive support systems to ensure the continued prosperity of this vital sector.

The Kisan Call Center (KCC) in Punjab, India, represents an innovative and crucial interface between farmers and agricultural support services (Godara et al. 2023). Over the years, it has become a cornerstone of agricultural assistance, offering farmers a platform to seek guidance, information, and solutions to their pressing agricultural concerns (Godara & Toshniwal, 2020; Godara & Toshniwal, 2022). The KCC, operated by the Punjab government, records and manages an extensive dataset of farmer query calls, encompassing various topics, from crop cultivation techniques to pest management strategies and government schemes (Chachra et al. 2020; Kaur et al. 2020).

This research paper embarks on a comprehensive analysis of the farmer query calls received by the KCC in Punjab, India, focusing on the dataset spanning from 2009 to the present day, comprising an impressive total of 2,403,592 query call logs. This dataset, carefully pre-processed to ensure its accuracy and reliability, provides a unique opportunity to gain insights into the challenges and needs of the agricultural community in Punjab. The objectives of this study are manifold. We aim to:

1. Explore the temporal trends in farmer query calls, elucidating how the volume of calls has evolved over the years. By doing so, we can identify shifting patterns in agricultural concerns, thereby informing policy and support initiatives.
2. Provide month-wise insights into the dataset, uncovering the seasonality of farmer queries. Understanding when farmers seek assistance most frequently can guide the timing of support services and interventions.
3. Conduct a district-wise analysis to map the geographical distribution of query calls. This enables the identification of regions with higher call volumes, facilitating targeted resource allocation.

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4. Categorise calls based on crop and query types to gain a granular perspective on farmers' specific challenges. This information will assist in tailoring support programs and policies to address the unique needs of different crops and query categories.

By undertaking this comprehensive analysis, we aspire to contribute to the body of knowledge surrounding Indian agriculture and the role of support services in enhancing its sustainability and productivity. Moreover, we hope that our findings inform evidence-based policy decisions, empower agricultural experts, and ultimately benefit the farmers of Punjab by addressing their evolving needs effectively. In doing so, we endeavour to ensure that Punjab's agriculture remains a vibrant and resilient sector, capable of meeting the nation's food security and economic development demands.

Material and Methods

The methodology employed in this research involved a series of structured steps to analyse the farmer query call dataset from the Kisan Call Center (KCC) in Punjab, India. These steps are outlined as follows:

1. Data Collection: The primary data source for this study was the KCC dataset, obtained from the Punjab state government's data servers. This dataset contains detailed information about farmer query calls, including the date and time of the call, caller's location (district), crop discussed, query type, and any relevant details provided during the call.
2. Data Preprocessing: Data preprocessing was essential to ensure the quality and consistency of the dataset. This involved cleaning the data by handling missing values, duplicates, and outliers. Additionally, date formats were standardised, and the data was categorised into specific crop and query types for further analysis. Data was aggregated to create subsets for various timeframes (e.g., year-wise, month-wise) and spatial scales (e.g., district-wise).
3. Temporal Analysis: To analyse year-wise and month-wise trends, we calculated the total number of query calls for each year and month. This provided insights into how the volume of calls has evolved and identified peak months of call activity.
4. Geospatial Analysis: District-wise distribution of query calls was analysed by calculating each district's total number of calls. This allowed us to identify regions with higher call volumes, aiding in targeted resource allocation and support services.
5. Categorical Analysis: Calls were categorised into different crop and query types, and the number of calls for each category was calculated. This analysis offered insights into the specific challenges faced by farmers about different crops and query types.
6. Data Visualization: Visual representations, such as charts and graphs, were created to illustrate the findings, making it easier for the audience to comprehend and interpret the results.
7. Interpretation and Inference: The results obtained from the analysis were interpreted to draw meaningful conclusions regarding temporal, geographical, and categorical trends in farmer query calls.
8. Policy Recommendations: The research findings were used to derive insights into the challenges faced by farmers in Punjab. These insights informed potential policy implications and interventions to address the identified issues.

In summary, this research followed a structured methodology encompassing data collection, preprocessing, analysis, and interpretation. It employed mathematical calculations to derive insights from the dataset. It offered valuable information about the dynamics of farmer query calls in Punjab and served as a foundation for evidence-based decision-making in agricultural policy and support services.

Results and Discussion

The year-wise analysis of farmer query calls from 2009 to 2023 in Punjab, India, reveals notable fluctuations and trends (Figure 1). The data shows a decreasing trend from 2009 to 2012, suggesting improving farming practices and knowledge. However, from 2013 onwards, there has been a consistent increase in query calls, reflecting evolving agricultural challenges. The significant peak in 2019 may be attributed to specific agricultural issues or government policies. Development of communication technology, increased access to information, weather phenomena during the period and economic conditions can also influence call volumes. Overall, the data underscores the need for adaptive and responsive agricultural support systems to address the dynamic needs of Punjab's farmers.

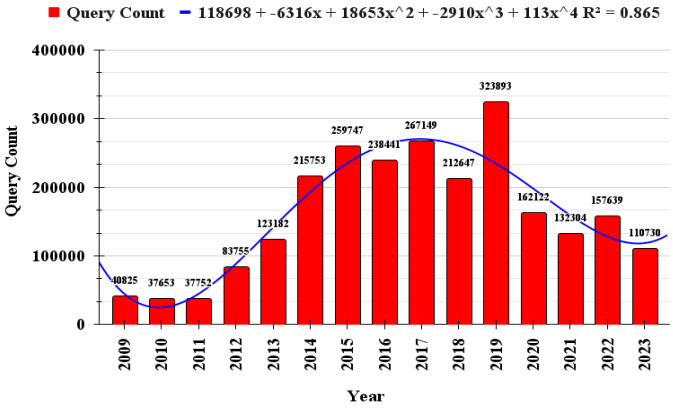

Figure 1. Yearwise query counts of farmer calls from 2009 to 2023 in Punjab, India

Figure 2 displays a month-wise analysis of farmer query calls in Punjab, India. It reveals distinct seasonal patterns and trends in query volumes. Months from June to September (monsoon and early post-monsoon period) consistently record the highest call volumes, with July peaking at 2.82 lakh calls. This reflects the critical role of weather-related concerns during the planting period and growing seasons (Bana et al. 2022). Further, the early season weed menace, seed treatment and nutrient management-related queries also remain a concern during this period (Bana et al. 2020; Arora et al. 2022).

Conversely, the months from November to February exhibit lower query counts, suggesting reduced farming activities during winter. January sees a slight increase in queries, possibly due to preparations for the upcoming

cropping season or an infestation of insect pests and diseases at the reproductive stages of *rabi* crops (Haldhar et al. 2017; Bana et al. 2022). Overall, the data highlights the strong influence of agricultural seasons and weather conditions on farmer queries, emphasising the need for timely and region-specific support and information dissemination (Figure 2).

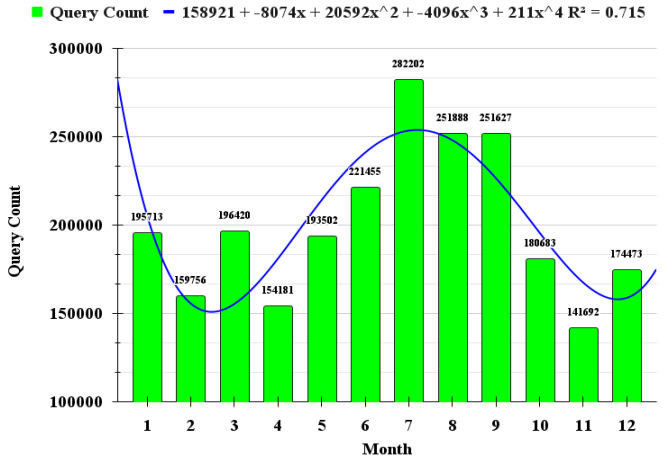

Figure 2. Month-wise analysis of query counts of farmer calls from 2009 to 2023 in Punjab, India

The districtwise analysis of farmer query calls in Punjab reveals notable variations in call volumes across different regions (Figure 3). With the highest query count at 3.32 lakh from Bhatinda stands out as a district with significant agricultural concerns. Sangrur and Mansa also report substantial call volumes, indicating the prevalence of agriculture-related issues in these areas. Patiala and Gurdaspur follow closely, emphasising farmers' diverse agricultural challenges. Conversely, districts like Kapurthala and Sahibzada Ajit Singh Nagar report lower query counts, suggesting relatively fewer immediate agricultural concerns in these regions. These variations underline the importance of tailoring support and interventions to address the specific needs of farmers in different districts.

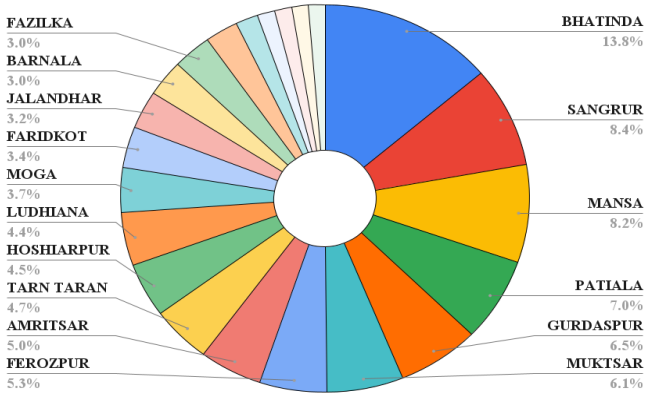

Figure 3. District-wise analysis of query counts of farmer calls from 2009 to 2023 in Punjab, India

The top 10 crop query analysis in fig. 4 reveals vital insights into farmers' agricultural priorities and concerns in Punjab, India. Rice (Dhan) and Wheat dominate the list, underlining their pivotal roles in the state's agriculture. Cotton (Kapas) follows closely, reflecting the significance of the crop as a potential diversification option in the state and its role in the textile industry. Maize (Makka) crop with being fourth, highlights its potentiality in the cropping system diversification efforts of the Punjab state (Bamboriya et al. 2022). Potato, berseem, and green gram demonstrate crop diversity, highlighting the various crops cultivated. Citrus, pea (vegetable), and onion also make the list, indicating the relevance of horticulture and leguminous crops. These query counts emphasise the need for information and support related to these crops, influencing the region's agricultural policies and extension services (Figure 4).

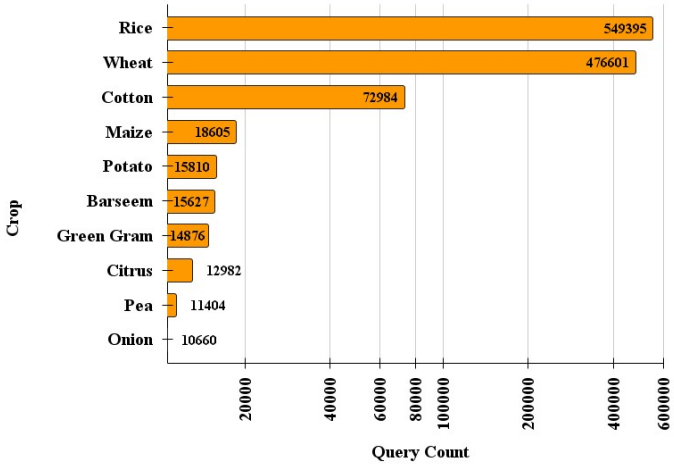

Figure 4. Farmers' agricultural priorities and concerns in top-10 crops of Punjab, India

The query type-wise analysis provides a comprehensive overview of the specific topics farmers in Punjab, India, seek information and assistance with (Figure 5). "Weather" emerges as the most frequently queried topic, with a significant query count of 1,120,532, highlighting the pivotal role of weather-related information in farming decision-making. "Plant Protection" and "Nutrient Management" follow, indicating a keen interest in pest and disease control and optimising nutrient usage. "Fertilizer Use" and "Varieties" are also prominent, reflecting farmers' concerns about the effective use of fertilisers and the selection of crop varieties. "Cultural Practices" and "Weed Management" signify the importance of agronomic practices in enhancing crop yields. Queries related to "Seeds" suggest focusing on crop seed quality and selection. Furthermore, "Government Schemes," "Training and Exposure," and "Training and Exposure" represent the broader support and resources that farmers seek from government programs and training initiatives. This analysis underscores the multifaceted nature of agricultural queries, emphasising the need for tailored extension services, timely information dissemination, and support in these critical areas to enhance agricultural productivity and sustainability in Punjab.

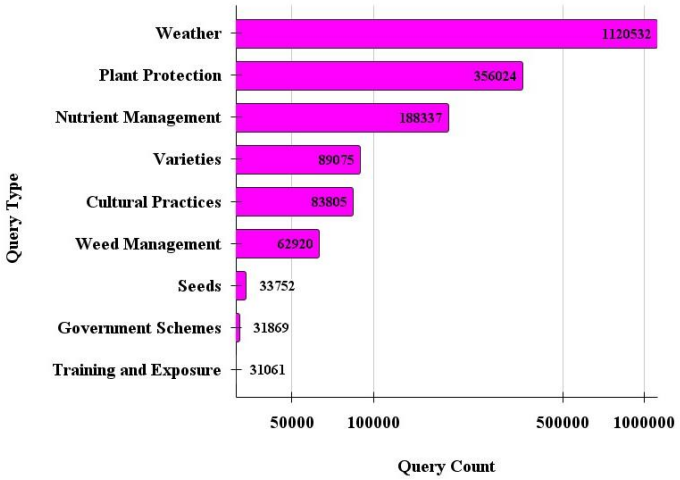

Figure 5. Query-type-wise analysis of farmer calls from 2009 to 2023 in Punjab, India

Several policy recommendations emerge based on the month wise analysis of farmer query calls. To address the distinct seasonal patterns in call volumes, policymakers should prioritise timely information dissemination during peak months (June to September) when weather-related concerns are prevalent. During lower query months (November to February), efforts should shift towards off-season support, including training and capacity-building initiatives to prepare farmers for upcoming cropping seasons. Strengthening data collection mechanisms for specific queries and leveraging digital platforms to provide year-round information access is crucial. Public-private partnerships and awareness campaigns can further enhance the effectiveness of agricultural support services, ensuring a more responsive and farmer-centric approach (Godara et al. 2022). The district-wise analysis of farmer query calls in Punjab highlights the need for targeted and region-specific policy interventions. With higher query counts, districts like Bhatinda, Sangrur, and Mansa should receive focused support to address prevalent agricultural challenges. In contrast, districts with lower query counts, such as Kapurthala and Sahibzada Ajit Singh Nagar, can benefit from proactive knowledge transfer programs and agricultural extension services. Policymakers should leverage the data-driven insights gained from this analysis to tailor their decisions and resource allocation to the unique needs of each district, ultimately promoting sustainable agriculture and enhancing the well-being of farmers across Punjab.

The analysis of the top 10 crops discussed in farmer query calls underscores the significance of specific crops in Punjab's agriculture. Policymakers should prioritise resources and research efforts towards paddy (Dhan), wheat, and cotton (Kapas), which dominate the list and are vital for the state's economy. To encourage crop diversification and reduce dependency on a few crops, targeted support and incentives for alternative crops like maize (Makka), potato, and berseem should be implemented (Bana et al. 2015; Pooniya et al. 2018). Additionally, promoting knowledge dissemination and extension services for these crops can enhance agricultural productivity and resilience, ultimately benefiting the farming community and the agricultural sector. The query type-wise analysis highlights the critical informational needs of farmers in Punjab, suggesting specific policy directions to enhance agricultural practices and productivity. Given the importance of "Weather" queries, policymakers should prioritise the accessibility of accurate and timely weather forecasts and advisories. Addressing "Plant Protection" and "Nutrient Management" concerns calls for promoting integrated pest management practices and optimising nutrient usage, including sustainable alternatives (Yogi et al. 2023).

Furthermore, for topics like "Fertilizer Use" and "Varieties," tailored guidance and information dissemination should be emphasised to assist farmers in making informed decisions about fertilizers and crop varieties. Additionally, supporting "Cultural Practices" and "Weed Management" through extension services and training can enhance crop management techniques (Gandhi et al. 2019; Bernard et al. 2019). Lastly, promoting awareness and accessibility of "Government Schemes" and "Training and Exposure" opportunities can empower farmers with valuable resources and knowledge, ultimately bolstering Punjab's agricultural sector's resilience and sustainability.

Conclusion

In conclusion, this comprehensive study of farmer query calls to the Kisan Call Center (KCC) in Punjab, India, spanning over a decade, has provided valuable insights into the dynamic landscape of agriculture in the region. The temporal analysis revealed fluctuations in query call volumes over the years, with notable increases in recent times. These trends underscore farmers' evolving needs and challenges and highlight the crucial role of responsive agricultural support systems. The districtwise analysis shed light on the varying agricultural concerns across different regions of Punjab. It emphasised the importance of tailoring support and interventions to address each district's specific needs, recognising the farming communities' unique agricultural priorities. Examining the top 10 crops and query types underscored the significance of specific crops and topics in farmers' minds. It reinforced the importance of providing targeted information and resources related to these critical crops and agricultural subjects. Overall, this study is a valuable resource for policymakers, agricultural experts, and stakeholders in Punjab. It underscores the necessity of data-driven decision-making and the importance of adapting agricultural support services to the evolving needs of the farming community. By aligning policies and initiatives with the findings of this research, Punjab's agriculture can thrive in the face of changing challenges and continue to contribute significantly to the state's economy and food security.

Declaration of Interests

The authors have no conflict of interest to declare.

Data Sharing

All relevant data are within the manuscript.

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