Analysing Indian farmers' information needs on edible oil crops using Kisan Call Center data

Samarth Godara[1], Rounak Kumar[1], GK Jha[1], RS Bana[2], RL Choudhary[3]*, Sudeep Marwaha[1], Rajender Parsad[1], Deepak Singh[1] and Raju Kumar[1]

[1]*ICAR-Indian Agricultural Statistics Research Institute, New Delhi 110012, India*
[2]*ICAR-Indian Agricultural Research Institute, New Delhi 110012, India*
[3]*ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur 321303, Rajasthan, India*
*Corresponding author: rl.choudhary@icar.gov.in

Abstract

Due to the increasing complexity of agricultural challenges faced by Indian farmers, there is a critical need for data-driven insights to tailor extension services, enhance productivity, and ensure sustainable farming practices. In this scenario, understanding farmers' information demands can significantly improve support mechanisms and policy interventions. With this aim in focus, the present study leverages the Kisan Call Center (KCC) dataset to analyze the information demands of Indian farmers regarding three key edible oil crops: groundnut, mustard, and soybean. By examining the queries received from farmers, the research identifies significant patterns and trends in agricultural challenges and practices across different states and over multiple years. The study categorises these queries into types such as agronomic practices, pest management, market information and more. Key findings reveal notable geographical variations in query volumes, underscoring the need for localized agricultural extension services. Based on these insights, the study proposes actionable policy recommendations to enhance plant protection services, improve weather forecasting and advisory services, promote advanced crop varieties, and disseminate market information more effectively. These recommendations aim to address the specific needs of farmers, thereby supporting informed decision-making, boosting productivity, and enhancing livelihoods. Future research is recommended to monitor the evolving information demands of farmers and to refine extension services accordingly.

Introduction

Extension activities in edible oil crops are critically important in India for several reasons, reflecting the agricultural, economic, and nutritional landscape of the country. Edible oil crops such as groundnut, mustard, and soybean are vital to India's agricultural economy (Raj *et al.,* 2023; Bana *et al.,* 2024). They are major cash crops that contribute significantly to the income of millions of small and marginal farmers (Jha *et al.,* 2012; Langadi *et al.,* 2021). Enhancing the productivity and profitability of these crops through effective extension services can directly improve the livelihoods of these farmers.

India is one of the largest consumers of edible oils in the world. Despite significant domestic production, the country heavily relies on imports to meet its demand, leading to a substantial outflow of foreign exchange (Kurup *et al.,* 2015; Choudhary *et al.,* 2023). Strengthening extension services and effective management strategies for vegetable oils can help increase domestic production, reduce dependency on imports, and improve the country's trade balance. Edible oils are a crucial part of the Indian diet, providing essential fatty acids and serving as a key source of dietary energy. Ensuring the availability of high-quality, locally produced edible oils can contribute to food security and improve the nutritional standards of the population (Choudhary *et al.,* 2017; Choudhary *et al.,* 2019).

Edible oil crops face various agronomic challenges including pest and disease infestations, climate variability (Choudhary *et al.,* 2021), and soil fertility issues (Choudhary *et al.,* 2016). Extension activities provide farmers with the latest research-based practices for pest management, disease control, and soil health improvement, helping them overcome these challenges and maintain healthy crop yields. Effective extension services promote sustainable farming practices. This includes educating farmers about crop rotation, integrated pest management (IPM), and the judicious use of fertilizers and water resources. Sustainable practices are essential for maintaining soil health, reducing environmental impact, and ensuring long-term agricultural productivity (Shirzad *et al.,* 2020; Meena *et*

al., 2023). Extension activities in edible oil crops are vital for enhancing agricultural productivity, ensuring economic stability for farmers, reducing import dependency, promoting nutritional security, and fostering sustainable agricultural practices (Suresh *et al.,* 2016). Strengthening these services can lead to significant improvements in the overall agricultural sector and contribute to the socio-economic development of rural communities in India.

Agricultural development in India faces unique challenges, particularly in the context of disseminating information and best practices to farmers scattered across diverse geographical regions. Recognizing the critical need for effective communication and support, the Ministry of Agriculture and Farmers Welfare, Government of India, launched the Kisan Call Centre (KCC) initiative on January 21, 2004 (Ray and Chowdhury, 2015). This program aims to provide personalized agricultural advice to farmers via toll-free numbers, addressing a range of agricultural issues and improving farm productivity. The KCC operates through 21 different locations across India, ensuring extensive reach and accessibility. The dataset generated from KCC interactions, managed by the ICAR-Indian Agricultural Statistics Research Institute in New Delhi, comprises approximately 40 million query calls collected from 2006 to the present (*https://kcc-chakshu.icar.gov.in/*). This rich repository of data captures a wide range of farmer inquiries, including details such as state name, district name, block name, cropping season, and crop type.

Research conducted in Mahaboobnagar District of Telangana State analyzed the utilization of KCC services among farmers (Kavitha *et al.,* 2017). The study highlighted the significance of KCC in disseminating timely and relevant agricultural information, which directly contributes to enhanced agricultural practices and productivity. A policy paper by NAARM explored the critical aspects of KCC operations, emphasizing the necessity for a robust support system for farmers (Soam *et al.,* 2015). It also discussed the policy framework required to sustain and improve the efficiency of KCCs. Another study focused on developing an attitude scale for farmers regarding KCC services (Koshy and Kumar, 2016). This research aimed to gauge the perception and acceptance levels of KCC among the dairy farming community, indicating a generally positive attitude towards the services provided. These studies collectively underscore the critical role of KCCs in enhancing agricultural knowledge dissemination, the positive reception by the farming community, and the need for supportive policies to ensure their sustainability and effectiveness.

The introduced AgriMine framework by Godara *et al.*

(2022) utilized deep learning and spatio-temporal analytics to analyze data from farmers' helplines, revealing hidden insights and association rules in agricultural issues. It aims to diagnose nationwide agricultural problems by mining a textual database of farmer queries and responses over five years. This innovative approach enhances the understanding of recurring agricultural challenges and the effectiveness of provided solutions. The presented AgrIntel framework by Godara *et al.* (2023) used spatio-temporal profiling to analyze nationwide plant protection problems using helpline data, focusing on diseases such as rice blast. This approach helps in understanding the geographic and temporal patterns of plant diseases and aids in effective management strategies. The study emphasizes the importance of integrating helpline data for comprehensive agricultural problem-solving. The study by Godara *et al.* (2020) presented an innovative approach combining sequential pattern mining with multi-criteria decision-making (MCDM) techniques, specifically TOPSIS, to analyze and characterize farmers' queries. This methodology aims to extract meaningful association rules and support decision-making in agricultural contexts. The integration of these techniques provides a robust framework for understanding complex agricultural data and improving advisory services. Another study by Godara Godara *et al.* (2024) analyzed over four million farmer queries to the KCC in Rajasthan from 2009 to 2023, providing valuable data-driven insights to enhance agricultural extension services. The findings are intended to inform evidence-based policy decisions and tailor support services to improve agricultural productivity. This comprehensive analysis identifies key areas of concern for farmers and suggests strategies for targeted interventions.

This present study focuses on analyzing the information demand of Indian farmers specifically regarding three major edible oil crops: groundnut, mustard, and soybean. By examining the KCC data, this research aims to uncover insights into the types of queries farmers have about these crops, the geographic distribution of these queries, and trends over time. The objective is to provide actionable recommendations for policy and extension services to better address the informational needs of farmers and support their agricultural practices more effectively. By understanding the patterns and specific concerns of farmers as revealed through their interactions with the KCC, this study endeavours to contribute to the enhancement of agricultural extension services and, ultimately, to the improvement of farmers' productivity and livelihoods. The study also examines trends over time, highlighting changes in farmers' concerns and informational needs. Additionally, queries are categorized by type, such as pest management,

agronomic practices, market information and more, to provide a comprehensive understanding of farmers' issues. These insights are used to formulate actionable policy recommendations to improve agricultural extension services.

Materials and Methods

The methodology for this study involves several key steps (Fig. 1), each crucial for extracting and analyzing the data from the KCC to derive meaningful insights. Following is a detailed explanation of each step.
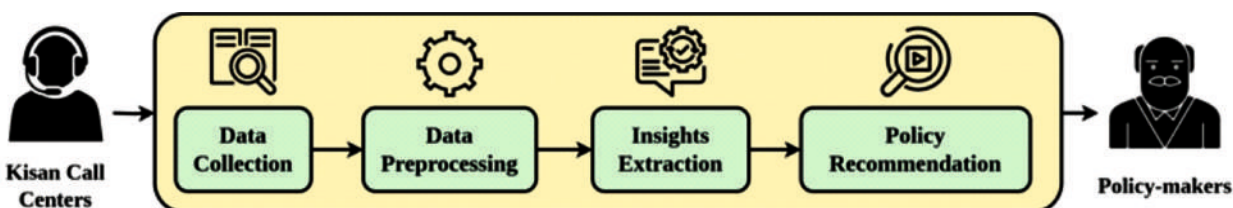

Fig. 1: Block diagram of the methodology used to extract the targeted insights

Data collection (acquisition)

The study begins with the acquisition of the KCC dataset, which contains call records related to agricultural queries. This dataset is particularly focused on queries about three major edible oil crops: groundnut, mustard, and soybean. The data includes various attributes such as the state name, district name, block name, cropping season, crop type, and specific details of the farmers' queries. Access to this dataset is facilitated through the KCC data repository maintained by the ICAR-Indian Agricultural Statistics Research Institute.

Preprocessing (data cleaning and transformation)

The raw call logs from the KCC dataset undergo a meticulous preprocessing phase to ensure high data quality for subsequent analysis. This step involves:

- Noise removal: Identifying and eliminating incomplete records, duplicate entries, and irrelevant information to clean the dataset.
- Data transformation: Structuring the cleaned data into a suitable format for analysis, including categorizing queries based on predefined types such as pest management, agronomic practices, and market information.
- Handling missing data: Addressing missing values through imputation techniques or by excluding records with significant missing information.

State-wise, year-wise, and type-wise insights extraction (data analysis)

The cleaned dataset is then analyzed to extract insights based on states, years, and query types, revealing patterns and trends in farmers' concerns. This analysis involves several techniques:

- Geographical analysis: Filtering and aggregating data at the state and district levels to identify regional variations in the nature and frequency of queries. This helps pinpoint specific areas with significant agricultural issues or information needs.
- Temporal analysis: Examining queries over different years to identify trends and changes in informational demands over time. This includes:
- Year-wise analysis: Assessing the frequency and nature of queries for each crop across different years.
- Query type classification: Categorizing queries into different types such as agronomic practices, pest management, and market information using natural language processing (NLP) and machine learning algorithms. This helps in understanding the primary concerns and informational needs of farmers.

Policy recommendations (actionable insights)

Based on the extracted insights, the study formulates actionable policy recommendations to address the identified agricultural challenges and improve farmers' livelihoods. These recommendations are tailored to meet the localized needs of farmers which include:

- Enhanced Plant Protection Services: Allocating resources for pest and disease management in regions with high demand.
- Weather Forecasting and Advisory Services: Improving weather forecasting and providing timely advisories to assist farmers in decision-making.
- Fertilizer and Nutrient Management: Implementing extension programs to educate farmers about proper fertilizer use and nutrient management.
- Market Information Dissemination: Strengthening efforts to provide market information and facilitate access to markets.

Results and Discussion

Figure 2 presents the distribution of query call counts from various Indian states to the KCC related to the

groundnut crop, highlighting the demand for agricultural information. Rajasthan leads with the highest number of calls (117,105), followed closely by Gujarat (106,381) and Tamil Nadu (67,586). Andhra Pradesh (52,650) and Maharashtra (51,052) also show significant engagement. In contrast, states like Bihar (1,013) and Punjab (902)

have much lower call volumes, indicating regional variations in information-seeking behaviour among farmers. These insights reflect the differing agricultural challenges and the extent of farmers' reliance on the KCC across India.
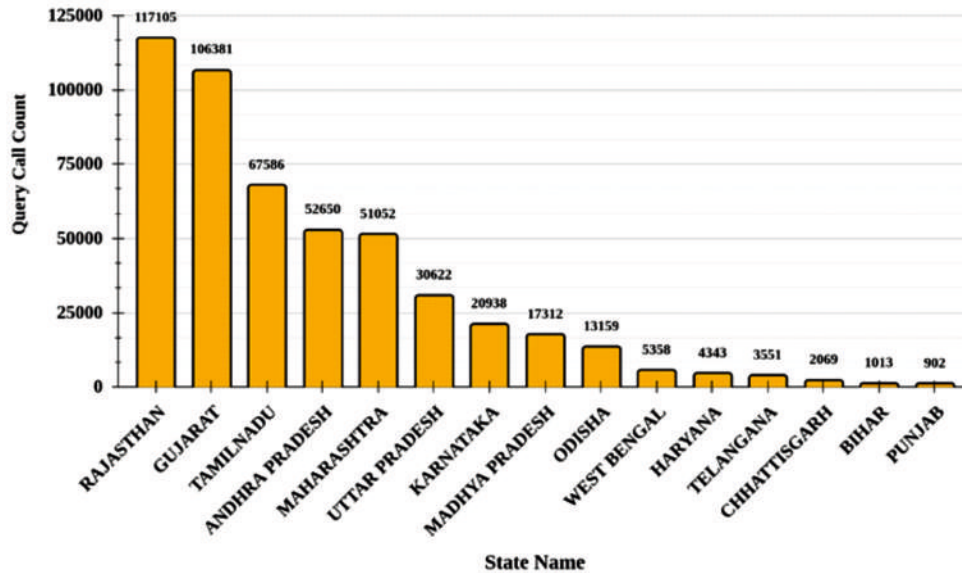

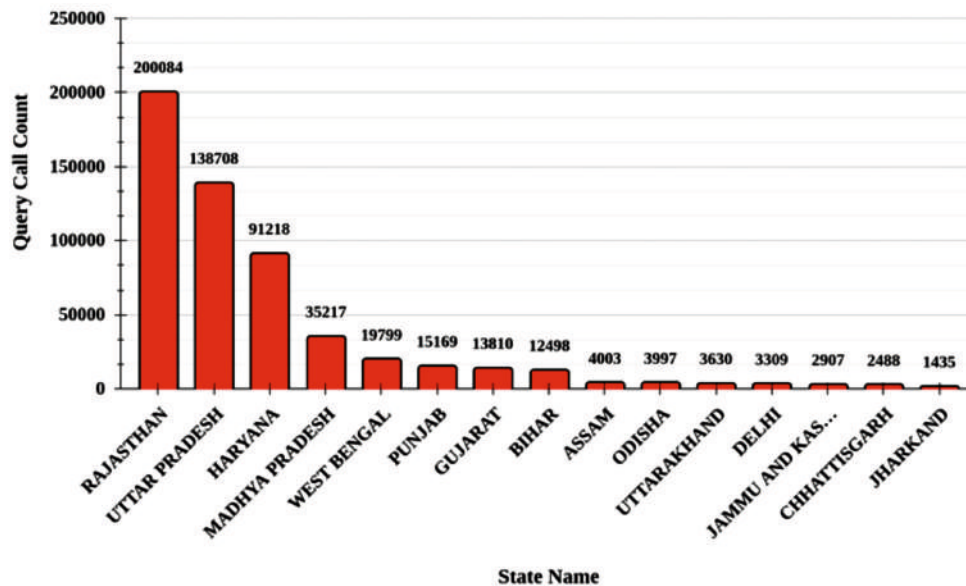Fig. 2: State-wise number of query calls related to the groundnut crop

Fig. 3: State-wise number of query calls related to the mustard crop

Figure 3 details the query call counts related to mustard crops from various Indian states to the KCC. Rajasthan leads with the highest number of queries (200,084), followed by Uttar Pradesh (138,708) and Haryana (91,218), indicating a strong demand for mustard-related information in these regions. States like Madhya Pradesh

(35,217) and West Bengal (19,799) also show significant engagement. In contrast, states such as Jharkhand (1,435) and Chhattisgarh (2,488) have lower query counts, reflecting lesser demand or possibly smaller cultivation areas for mustard. This distribution highlights the varying significance of mustard

cultivation across different states in India.

Figure 4 shows the distribution of query call counts related to soybean crops from various Indian states to the KCC. Madhya Pradesh has the highest number of queries (237,478), indicating a significant demand for soybean-related information. Maharashtra follows with 144,968 calls, and Rajasthan with 43,075 calls, highlighting the importance of soybean in these states. States like Gujarat (9,345) and Uttar Pradesh (6,751) have moderate query counts, while regions such as Himachal Pradesh (347) and Punjab (380) show relatively low engagement. This data reflects the varying levels of soybean cultivation and the associated need for information across different states in India.
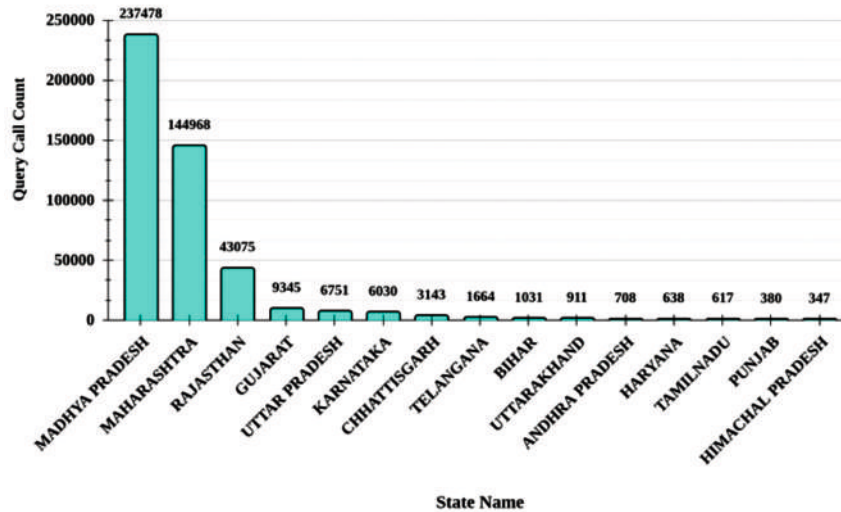

Fig. 4: State-wise number of query calls related to the soybean crop

Figure 5 illustrates the fraction of query call counts related to groundnut crops received by the KCC over various years. There is noticeable variability in the fraction of calls across the years, with peaks in 2013 (0.0210) and dips in 2018 (0.0078). The early 2010s, specifically 2011 (0.0205) and 2013, show relatively higher engagement, indicating increased demand for groundnut-related information. In contrast, mid-decade years such as 2015 (0.0094) and 2017 (0.0097) show lower fractions. The recent years, 2022 (0.0180) and 2023 (0.0185), indicate a resurgence in query fractions, suggesting a renewed interest or emerging issues in groundnut farming.
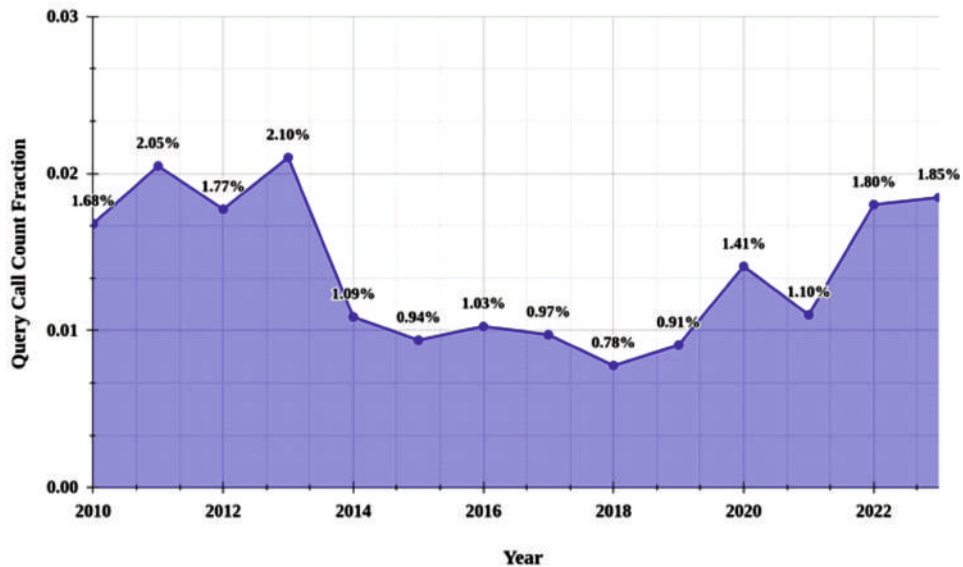

Fig. 5: Year-wise number of query calls related to the groundnut crop

Figure 6 presents the fraction of query call counts related to mustard crops received by the KCC from 2010 to 2023. The fraction peaked in 2021 (0.0291), indicating a significant increase in demand for mustard-related information that year. Earlier peaks include 2012 (0.0262) and 2010 (0.0229), with a noticeable dip in 2017 (0.0081) and 2018 (0.0074). The period from 2014 to 2019 shows relatively lower fractions, suggesting reduced engagement during these years. However, there is an upward trend again in 2022 (0.0239) and 2023 (0.0195), reflecting renewed interest or emerging issues in mustard cultivation.
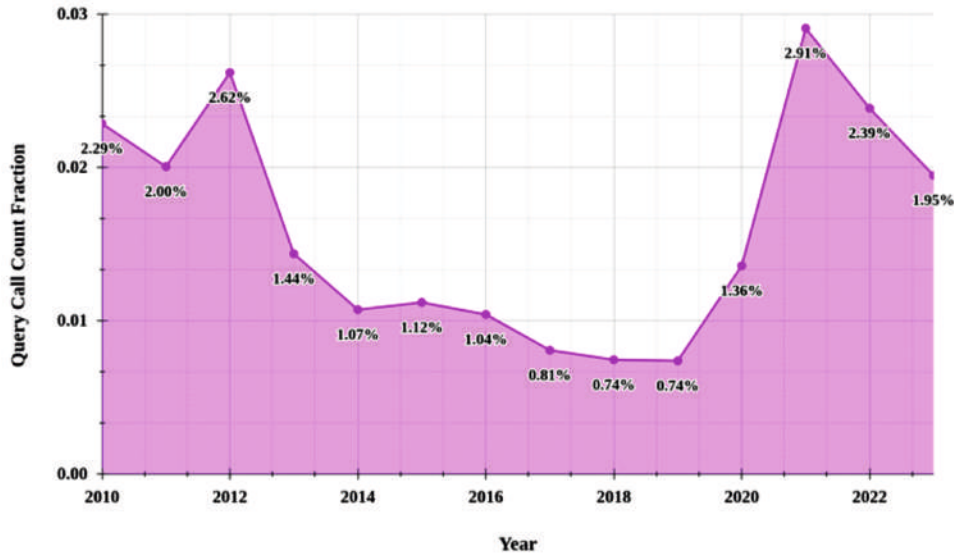
Fig. 6: Year-wise number of query calls related to the mustard crop

Figure 7 shows the fraction of query call counts related to soybean crops received by the KCC over various years. The fraction of calls peaked in 2012 (0.0284) and 2013 (0.0248), indicating high demand for soybean-related information during these years. Following this peak, there was a notable decline, with the lowest fractions occurring in 2021 (0.0061) and 2020 (0.0071). The years 2017 to 2019 also show relatively low engagement. However, there is a resurgence in 2022 (0.0158) and 2023 (0.0138), suggesting an increasing interest or emerging challenges in soybean farming in recent years.
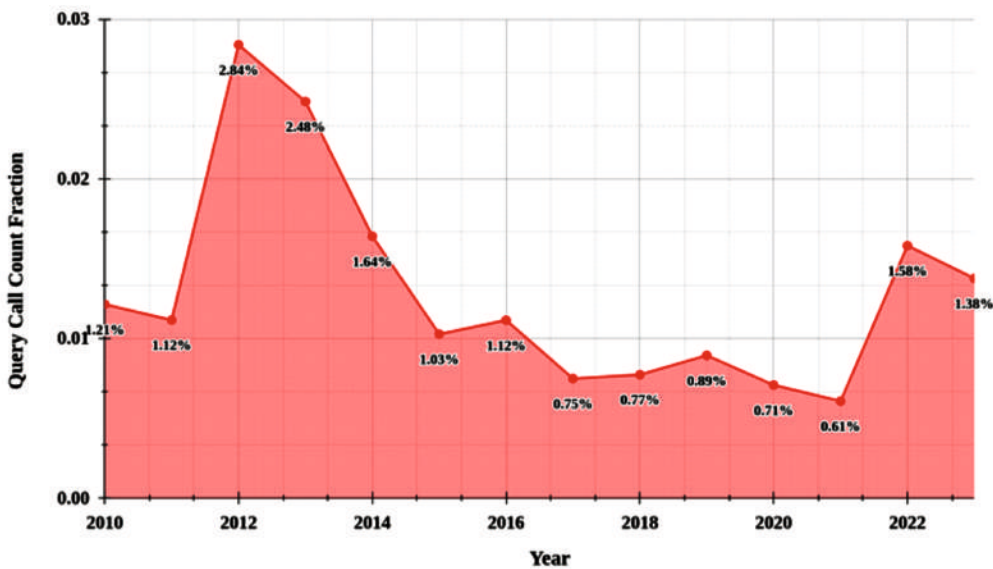
Fig. 7: Year-wise number of query calls related to the soybean crop

Figure 8 summarizes the distribution of query call counts related to groundnut crops across different query types received by the KCC. The highest number of queries (158,844) pertain to plant protection, indicating that pest and disease management is the primary concern for groundnut farmers. Weather-related queries (65,200) and fertilizer use (37,090) are also significant, reflecting the importance of climatic conditions and nutrient application in groundnut cultivation. Queries about nutrient management (32,369) and cultural practices (25,583) further highlight the need for detailed agronomic guidance. Additionally, farmers seek information on varieties (23,566), market information (18,786), weed management (17,583), seeds (15,130), and optimal sowing times (11,089), showcasing a broad spectrum of informational needs.
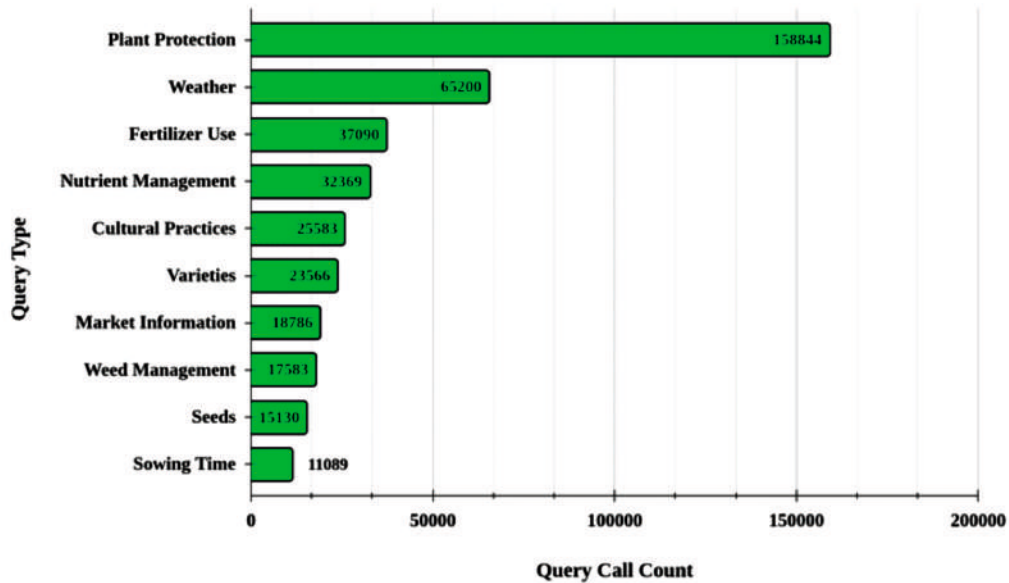

Fig. 8: Query type-wise number of query calls related to the groundnut crop

Figure 9 details various queries related to mustard crop management, revealing insights into farmers' priorities. Plant protection emerges as the most frequent concern, with 116,155 queries, indicating a significant focus on combating pests and diseases to ensure crop health and yield. Weather-related inquiries follow closely at 88,298 calls, underscoring the importance of climate conditions in mustard cultivation. Varieties are another key area of interest, with 67,733 queries, reflecting farmers' quest for suitable seed options to optimize production.
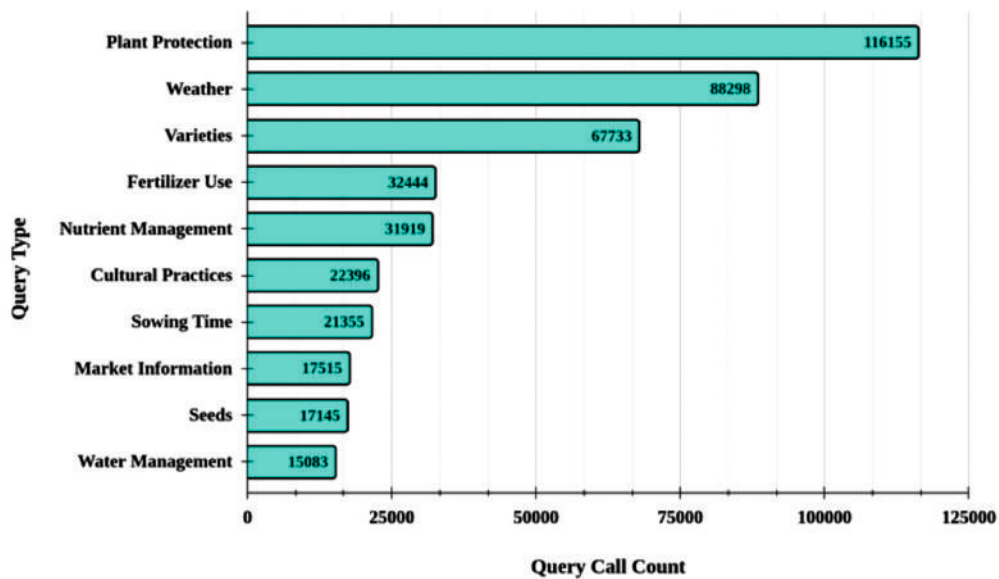

Fig. 9: Query type-wise number of query calls related to the mustard crop

Fertilizer use and nutrient management also feature prominently, with 32,444 and 31,919 calls respectively, highlighting efforts to enhance soil fertility and crop nutrition. Cultural practices and sowing time complete the queries, showcasing farmers' holistic approach to managing mustard crops through tailored cultivation techniques and optimal timing for planting.

Figure 10 presents data on various queries related to soybean crop management. Plant protection appears to be the most frequent concern, with 139,077 calls, indicating a significant focus on pest and disease control among soybean farmers. Weather-related inquiries

follow at 49,700 calls, highlighting the importance of weather conditions in crop planning and management. Market information, with 38,314 queries, suggests farmers' interest in pricing and market trends. Fertilizer use and weed management also show substantial interest, with 30,760 and 29,304 calls respectively, reflecting concerns about optimizing crop health and yield. Varieties, nutrient management, seeds, and cultural practices round out the queries, underscoring the comprehensive approach farmers take to maximize soybean production through informed decision-making and best practices in crop management.
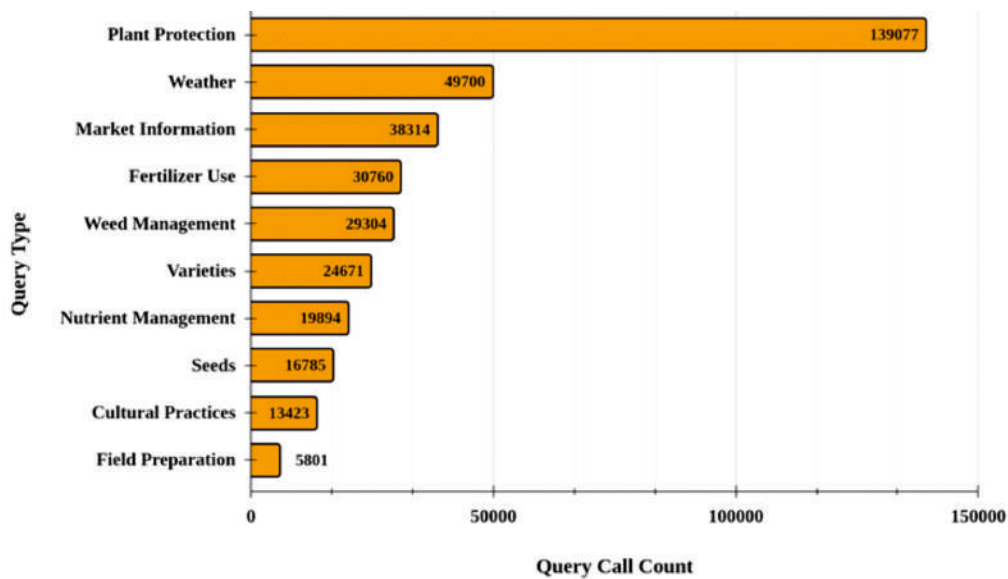

Fig. 10: Query type-wise number of query calls related to the soybean crop

Policy recommendations

Policy recommendations for groundnut cultivation include several key strategies aimed at enhancing agricultural productivity and farmer welfare. Firstly, there is a critical need to bolster plant protection services, particularly in high-query states like Rajasthan, Gujarat, and Tamil Nadu, by allocating resources towards improved pest and disease management. This initiative aims to meet the substantial demand for information and support from farmers in these regions. Secondly, enhancing weather forecasting capabilities and delivering timely advisories will empower farmers to make informed decisions regarding crop management in response to climatic conditions. Additionally, promoting effective fertilizer and nutrient management practices through extension programs is essential to optimize soil health and enhance crop yield. Lastly, efforts should focus on strengthening the dissemination of market information and improving market access for

farmers. These measures aim to equip groundnut farmers with the necessary tools and knowledge to navigate agricultural challenges effectively and capitalize on market opportunities.

Policy recommendations for mustard cultivation are centred around several strategic initiatives aimed at enhancing crop productivity and sustainability. Firstly, implementing robust plant protection programs is crucial, particularly in states like Rajasthan, Uttar Pradesh, and Haryana, where there is a high demand for pest and disease management services. This initiative seeks to address the specific challenges faced by mustard farmers in combating agricultural pests and diseases effectively. Secondly, strengthening weather forecasting and advisory services is essential to provide timely information to farmers, enabling them to make informed decisions on crop management practices in response to weather conditions. Furthermore, promoting the development and adoption of improved mustard

varieties is key to enhancing yield and resilience. This involves providing farmers with access to information and resources that facilitate the adoption of high-yielding and disease-resistant varieties. Lastly, conducting training programs on fertilizer use and nutrient management tailored to mustard cultivation aims to optimize soil health and crop nutrition, thereby supporting sustainable agricultural practices. These policy recommendations collectively aim to empower mustard farmers with the necessary tools and knowledge to improve their agricultural outcomes and economic well-being.

Policy recommendations for soybean cultivation focus on strategic interventions aimed at improving crop yield and farmer livelihoods. Firstly, implementing comprehensive plant protection initiatives is crucial, particularly in states like Madhya Pradesh and Maharashtra, where there is a high demand for effective pest and disease management strategies. These initiatives aim to safeguard soybean crops against prevalent threats and enhance their resilience. Secondly, strengthening weather forecasting services and providing timely advisories to soybean farmers will empower them to make informed decisions regarding crop management practices in response to changing weather patterns. Moreover, enhancing the dissemination of market information and improving market access for soybean farmers, especially in states with substantial query call counts like Madhya Pradesh and Maharashtra, is essential. This effort seeks to equip farmers with the knowledge needed to make informed decisions about crop sales and pricing, thereby improving their economic outcomes. Lastly, promoting awareness and training on effective weed management practices specific to soybean cultivation aims to reduce yield losses and improve overall crop quality. These policy recommendations collectively aim to enhance the productivity, sustainability, and profitability of soybean farming while addressing specific regional challenges and needs.

Conclusion

This study offers valuable insights into the information needs of farmers cultivating Groundnut, Mustard, and Soybean crops, identifying specific query types that dominate agricultural inquiries. Drawing from these insights, actionable policy recommendations have been developed to tackle the agricultural challenges identified and meet the needs of farmers effectively. The analysis highlights significant geographical variations in farmers' query call counts across different states, underscoring the necessity for customized extension services and targeted interventions to address localized agricultural needs optimally. Emphasizing the pivotal role of agricultural extension services, the study underscores

their critical function in providing timely information and support to farmers. By empowering farmers with knowledge, these services enable informed decision-making, enhance productivity, and ultimately improve livelihoods in agricultural communities. Moving forward, there is a clear need for continued research and implementation efforts. These efforts should assess the impact of the proposed policy recommendations, monitor shifts in farmers' information demands over time, and continually refine extension services to adapt to evolving agricultural landscapes and emerging challenges effectively.

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