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Analysis of Socio-economic Impacts of COVID-19 on Agricultural Practices Using Stepwise Regression

Manju Prem S. [a++*], Mohanraj M. [b++], Sneha M. A. [c#], Swadhin Priyadarsinee [d++] and Pooja Krishna J. [e†]

[a] Department of Agricultural Extension Education, College of Agriculture, Vellayani, Kerala Agricultural University, Kerala, India.
[b] Department of Agricultural Extension, College of Agriculture, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India.
[c] AICRP on Small Millets, University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India.
[d] Department of Agricultural Extension, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, India.
[e] College of Agriculture, Vellayani, Kerala Agricultural University, Kerala, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The COVID-19 pandemic has profoundly impacted rural farming communities, revealing significant shifts in economic factors, production methods, and farm management practices. This study, conducted in Chikkaballapur district, Karnataka, delves into the socio-economic ramifications of the

[++] Ph.D. Scholar;
[#] JRF;
[†] Research Assistant;
**Corresponding author: Email: manju-2021-21-050@student.kau.in;*

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pandemic on agricultural practices and the livelihoods of farmers. Utilizing a stepwise regression analysis approach, the research identifies influential variables such as changes in farm management, production, and health and sanitation facilities. Data were collected from 50 respondents during the pandemic's peak, employing statistical measures like mean, standard deviation, and coefficient of variation for comprehensive analysis. The findings underscore the intricate relationships between various factors affecting rural livelihoods and highlight the need for targeted interventions and policy measures. The study emphasizes the critical need for tailored policy interventions to address the socio-economic impacts of COVID-19 on agricultural practices. Specifically, policy recommendations include enhancing access to agricultural extension services, promoting digital agricultural solutions, investing in healthcare infrastructure, supporting economic diversification, and strengthening social protection mechanisms. By aligning policy interventions with the findings and indicators observed in the research, policymakers can effectively support rural farming communities in navigating the challenges posed by the pandemic and building resilience for the future.

Keywords: COVID-19; agricultural practices; socioeconomic impact; stepwise regression analysis; farm management.

1. INTRODUCTION

Farmers play a crucial role in society by providing the food we eat, making them vital to civilization. As India's population grows and farmland decreases, the importance of farmers increases. Without them, even white-collar jobs would struggle due to a lack of food supply. Known as the 'Backbone of India,' farmers work tirelessly, facing various challenges like climate change and natural disasters, yet they persist and make significant contributions to society [1]. Agricultural extension services are essential for spreading knowledge and skills within the farming community [2][3] emphasizes that these services aim to change farmers' behaviours, empowering them to participate actively in agricultural programs and boost farm productivity.

The COVID-19 pandemic affected people differently depending on their roles in society [4]. While some could switch to remote work, farmers had to continue working in the fields, exposing them to the virus [5]. The psychological repercussions of COVID-19 would likely be exacerbated in rural regions due to challenges in maintaining online social connections while adhering to social distancing and shielding measures. This is primarily attributed to deficient broadband infrastructure and insufficient mobile phone coverage prevalent in these areas [6]. The pandemic disrupted food supply chains, impacting both production and demand [7]. Grocery demand soared, causing shortages, while some farmers faced surplus production due to reduced foodservice demand [8]. Despite the increased risks, essential workers in agriculture and food industries, including farmers, continued their critical work [9].

In India, the pandemic's economic impact has been particularly harsh due to existing issues such as unemployment, low wages, and various unorganized sectors. This vulnerability has affected agriculture, with disruptions in labour, transportation, and misinformation impacting harvesting and sales. Poultry farmers, for instance, dealt with misinformation about COVID-19 spreading through chickens [10]. While media reports offer some information, there is a lack of systematic data on the pandemic's effects on farmers.

This study aims to analyse the socioeconomic conditions before and after the COVID-19 pandemic. It will explore how farmers adapt to factors like agricultural technology, market changes, farm management techniques, healthcare access, and migration trends. The study also seeks to predict these adaptations in terms of scores related to socioeconomic and environmental variables.

2. METHODOLOGY

The study was carried out in Chikkaballapur district of southern Karnataka during the 2020-21 period, focusing on the socioeconomic impact of the COVID-19 pandemic on rural lifestyles. Adopting an ex-post-facto descriptive research design, the study aimed to understand the current perceptions, challenges, and practices prevalent in the rural communities during the pandemic to draw valid conclusions. As described by Ray and Mondal [11], ex-post-facto

research seeks to determine the reasons behind an event after it has already occurred. The appropriateness of this design was determined based on its alignment with the study's objectives, variables, and sample size, as well as its relevance to the phenomenon under investigation.

In the study, the independent variables (X1-X11) encompass various factors related to the farmers' demographics, farming practices, and resource availability. These include age (X1), education (X2), family size (X3), farm size (X4), income (X5), number of farm vehicles (X6), number of farm animals (X7), water resource availability (X8) classified as Rainfed or Borewell, major crops grown (X9), health and sanitation facilities (X10), and service sector facilities (X11). On the other hand, the dependent variables (Y1-Y5) represent the changes observed due to COVID-19 across various domains. These are changes in economic factors such as income per acre (Y1), changes in production area (Y2), changes in farm technology usage (Y3), responses to market conditions (Y4), and changes in farm management practices (Y5).

Data were collected from 50 respondents during the peak of the pandemic, with 25 respondents from Chintamani taluk and 5 respondents each from the remaining 5 taluks. A pretested structured interview schedule was employed to gather information from the respondents. This schedule, developed based on the study's objectives and variables, underwent pretesting in a non-study area. Modifications were made post-pretesting in consultation with experts and officials to ensure its effectiveness and relevance. The interview schedule comprised both open-ended and closed-ended questions, offering flexibility during the interviews and covering topics such as demographic details, economic factors, farm characteristics, water availability, crop cultivation, health and sanitation, and access to services.

Statistical analysis was a crucial component of this study, employing various measures and methods to analyse the collected data comprehensively. Initially, the mean was calculated to determine the central tendency of the dataset, providing an average baseline. This measure helps in understanding the typical value of a variable within the dataset. Standard deviation, on the other hand, was utilized to assess the variability or dispersion of data points around the mean. It offers insights into the spread of the dataset and indicates the degree of variability or uncertainty within the data. The coefficient of variation, which measures variation independent of measurement units, was employed to compare the variability of different datasets. It allows for comparisons across different populations by standardizing the dispersion of data relative to the mean. Understanding these statistical measures is crucial for interpreting the results accurately and comprehensively. These measures provide insights into the distribution and variability of data, facilitating a deeper understanding of the socio-economic impacts of the COVID-19 pandemic on agricultural practices in the study area. Importantly, stepwise regression analysis, which is mainly focused in this paper, was emphasized to identify the most influential variables affecting the dependent variables. This method sequentially adds or removes independent variables based on their statistical significance, providing a more refined and interpretable regression model. Furthermore, correlation analysis using Karl Pearson's coefficient was conducted to examine relationships between variables, distinguishing between positive and negative correlations. The regression analysis, particularly stepwise regression, facilitated the exploration of potential causal relationships between variables, offering valuable insights into the factors impacting rural livelihoods during the pandemic.

The study provides a detailed analysis of the socio-economic impact of the COVID-19 pandemic on rural communities in Chikkaballapur district. The findings highlight the challenges faced by farmers and rural inhabitants in terms of economic losses, changes in agricultural practices, and access to essential resources and services. The rigorous statistical analysis, particularly the emphasis on stepwise regression, enabled a nuanced understanding of the complex relationships between various factors affecting rural livelihoods during these unprecedented times. The study underscores the need for targeted interventions and policy measures to support rural communities in adapting to the new normal and building resilience against future challenges.

Stepwise regression is a statistical method used in predictive modelling to systematically select the most relevant independent variables that optimize prediction accuracy while minimizing the number of variables included in the model [12]. This method iteratively adds or removes

independent variables based on their statistical significance, typically assessed through F-statistics and tolerance levels or p-values. It aims to identify the variables that have the strongest association with the dependent variable, often measured by the coefficient of determination (R^2). Stepwise regression includes procedures such as forward selection and backward elimination, where variables are either added or dropped based on their importance in explaining the variance in the dependent variable. Despite its popularity, stepwise regression has inherent limitations, including issues related to multicollinearity, biased significance levels, and the potential for overfitting. For example, issues related to multicollinearity may arise when independent variables are highly correlated with each other, leading to unstable estimates of regression coefficients and inflated standard errors. Biased significance levels may also occur due to the sequential nature of variable selection, where variables added earlier in the process may have inflated significance levels compared to those added later. Additionally, the potential for overfitting exists when the model is excessively complex, leading to poor generalization to new data. Therefore, caution was exercised when interpreting and applying the results of stepwise regression analyses, ensuring that the findings are not merely statistical artefacts but are theoretically meaningful and robust [13].

3. RESULTS AND DISCUSSION

The stepwise regression analyses conducted across three different models shed light on the influential factors affecting changes in economic factors (Y1), farm technology (Y3), and farm management (Y5). The remaining two least statistically significant dependent variables were eliminated in the process of stepwise regression.

For changes in economic factors (Y1), the analysis revealed that a change in farm management (Y5) was a significant predictor, accounting for approximately 12.4% of the variance in economic changes (R^2 = 0.124, Adjusted R^2 = 0.106, Std. Error = 3.704). This suggests that alterations in farm management practices have a recognizable impact on economic outcomes indicating the importance of effective farm management strategies in mitigating the economic effects of the pandemic.

Similarly, when examining changes in farm technology (Y3), two variables emerged as significant predictors: change in production (Y5) and health and sanitation facilities (X10). Together, these variables accounted for approximately 19.7% of the variance in farm technology changes (R^2 = 0.197, Adjusted R^2 = 0.162, Std. Error = 1.898). This indicates that improvements in production methods and health and sanitation facilities play crucial roles in technological advancements on farms underscoring the need for investments in infrastructure and technology adoption to enhance agricultural productivity and resilience.

For changes in farm management (Y5), three variables were identified as significant predictors: age (X1), education (X2), and changes in economic factors (Y1). These variables collectively explained approximately 31.5% of the variance in farm management changes (R^2 = 0.315, Adjusted R^2 = 0.271, Std. Error = 2.196). The results suggest that older age, higher education levels, and economic factors contribute significantly to the evolution of farm management practices.

The predictor variables identified in each stepwise regression model provide valuable insights into the factors that significantly influence changes in agricultural practices during the pandemic. For example, variables such as changes in farm management, age, education, and economic factors have emerged as significant predictors across different models. These findings underscore the multifaceted nature of factors shaping agricultural practices and highlight the importance of addressing socio-economic disparities and promoting education and training initiatives to empower farmers with the knowledge and skills needed to adapt to changing circumstances.

The interrelationships between predictor variables reveal complex dynamics that influence changes in economic factors, agricultural technology, and farm management. For instance, changes in economic factors, such as income fluctuations, can impact decisions regarding farm management practices and the adoption of agricultural technology. Farmers may adjust their management strategies in response to changes in income levels, reallocating resources or adopting new technologies to optimize production and minimize costs. Similarly, access to education and age may influence farmers' ability to adopt innovative technologies and adapt their farming practices to evolving market conditions, highlighting the importance of targeted interventions to support knowledge dissemination and skill development among farmers of all ages and educational backgrounds.

Table 1. Stepwise regression analysis: Change in economic factors (Y_1) with 11 causal variables

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1. Y5	.353[a]	0.124	0.106	3.704
a. Predictors: (Constant), y5				
b. Dependent Variable: y1				

Table 2. Stepwise regression analysis: Change in farm technology (Y_3) with 11 causal variables

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1. X10	.354[a]	0.125	0.107	1.960
2. Y2	.443[b]	0.197	0.162	1.898
a. Predictors: (Constant), x10				
b. Predictors: (Constant), x10, y2				
c. Dependent Variable: y3				

Table 3. Stepwise regression analysis: Change in farm management (Y_5) with 11 causal variables

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1. X2	.369[a]	0.136	0.118	2.415
2. X1	.493[b]	0.243	0.210	2.285
3. Y1	.562[c]	0.315	0.271	2.196
a. Predictors: (Constant), x2				
b. Predictors: (Constant), x2, x1				
c. Predictors: (Constant), x2, x1, y1				
d. Dependent Variable: y5				

Policy interventions should focus on addressing the identified predictors of changes in agricultural practices, such as promoting sustainable farm management techniques, investing in infrastructure to improve access to health and sanitation facilities, and supporting education and training programs to enhance farmers' capacity to adopt new technologies and practices. Additionally, policies should prioritize efforts to address socio-economic disparities and provide targeted support to vulnerable farming communities, ensuring that agricultural development initiatives are inclusive and equitable. By implementing evidence-based interventions that address the underlying drivers of change in agricultural practices, policymakers can promote sustainable and resilient agricultural systems that are better equipped to withstand future challenges, such as those posed by the COVID-19 pandemic.

4. CONCLUSION

The inhabitants of numerous rural areas, especially farmers, are notably susceptible to negative consequences stemming from COVID-19 infection [14]. This study has provided valuable insights into the socio-economic impacts of the COVID-19 pandemic on agricultural practices in Chikkaballapur district, Karnataka. The findings underscore significant changes observed in economic factors, production methods, agricultural technology usage, market responses, and farm management practices during these unprecedented times. Key factors such as changes in farm management and economic fluctuations have emerged as significant predictors of these shifts, highlighting their importance in adapting agricultural practices to the challenges imposed by the pandemic. It is imperative to recognize the relevance of these factors in shaping the resilience and adaptability of rural farming communities, emphasizing the need for targeted interventions and support mechanisms. Actionable steps, including promoting sustainable farm management techniques, investing in infrastructure to enhance access to essential resources, and providing education and training opportunities, are

essential to address the identified challenges and foster innovation in the agricultural sector. Looking ahead, further research areas and practical interventions should be explored to ensure the sustainability and resilience of agricultural systems in the face of future uncertainties. By implementing evidence-based strategies and policies that prioritize the well-being of farmers and rural communities, we can build a more resilient agricultural sector capable of overcoming the challenges posed by the pandemic and other global crises.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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