Rovedar

Research in Biotechnology and Environmental Science. 2023; 2(4): 102-107.

DOI: 10.58803/rbes.v2i4.17

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Short Communication

The Impact of the Rice Milling Industry on Agricultural Practices and Human Health in Karnataka, India

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ARTICLE INFO

Article History:
Received: 28/09/2023
Revised: 05/10/2023
Accepted: 01/12/2023
Published: 25/12/2023

Keywords:
Ecological
Impact
Pollutants
Rice mill

ABSTRACT

Introduction: The current study was conducted to assess the impact of pollutants derived from the rice mill environment on agricultural practices and human health conditions in Hassan District, Karnataka State, India. The aim of the study was to expplore the impact of the rice milling industry on the ecological status of the area.
Materials and Methods: A questionnaire was adapted to examine the status of the rice mill environment from January to June 2023. Five rice mills were randomly chosen, and the data was collected from 85 different family members residing at varying distances from these mills (0, 1, and 10 kilometers).
Results: Results indicated that more than 50% of the surveyed family members acknowledged the impact of pollutants from nearby rice mills on their environment, agriculture, and health. However, the impact on health and agricultural practices was insignificant, as indicated by scores ranging from 8 to 15 out of 30. When evaluating the environmental impact on a 60-point scale, it was evident that the contamination level exceeded 30 due to rice mill activities, signifying a substantial effect on the surrounding area. Within a 5-kilometer radius of the rice mills, the contamination adversely affected over 50% of the area, primarily stemming from rice mill activities. The contamination levels dropped to less than 20 at a distance of 10 kilometers from the mill location, indicating a reduction in impact with increased distance.
Conclusion: The overall analytical results and survey in the study suggest that rice mills should be located at a minimum distance of 0.5 kilometers from human settlements to mitigate contamination effectively. Encouraging environmentally friendly practices and adhering to principles, such as eco-efficiency and zero waste, are essential steps towards sustainable and pollution-free rice milling operations.

1. Introduction

Rice has a large water demand and its irrigation is considered to be 8 % of global anthropogenic emissions. Globally, irrigated low-land rice agricultural practices signify about 76% of rice cultivation, accounting for approximately 34% to 43% of the world's irrigation activities[1]. According to the non-hazardous waste management scale, the disposal of liquid and solid waste is a significant concern for industries since it requires a large area, and poor management can lead to severe environmental degradation and pose significant health to local communities[2].

The rice mills play a crucial role in the agricultural landscape but also generate a significant amount of waste. In recent years, there has been a growing interest in environmental issues, and sustainability has become the primary issue in Karnataka, especially in rice production areas [3,4]. Researchers like Jagbir Rehal et al.[5] have delved into various aspects of rice production, including a detailed outline of various post-harvest techniques, treatments in milling units, and factors affecting the quality and production of rice. The greenhouse gas emissions are released from the boilers in rice mills, particularly during

► *Cite this paper as:* Arpitha H R, Suresh S, Suresh B. The Impact of the Rice Milling Industry on Agricultural Practices and Human Health in Karnataka, India. Research in Biotechnology and Environmental Science. 2023; 2(4): 102-107. DOI: 10.58803/rbes.v2i4.17

power cuts and minor electrical issues. These emissions lead to air pollution in the rice mill.

The current study aimed to explore the impact of pollutants arising from rice mills on socio-economic factors and environmental concerns. This research is important as it evaluates the impact of pollutants resulting from the rice milling industry, offering valuable insights into the sustainability implications of the industrial sector.

2. Materials and Methods

2.1. Study area

Hassan district headquarters contains eight taluks, namely Alur, Arkalgud, Arsikere, Belur, Chennarayapatna, Hassan, Holenarsipur, and Sakleshpu. Additionally, it encompasses 38 hoblies and 2369 villages. According to the 2001 census, the total population of Hassan district stands at 1,721,669, with 1,416,996 residing in rural areas and 304,673 in urban regions. The rural and urban populations account for 82.31% and 17.69% of the district's population, respectively. Situated between 12°13′ and 13°33′ North latitudes and 75°33′ and 76º38′ East longitude, Hassan district has a total area of 6826.15 Square Kilometers. The maximum length of the district, from south to north, is about 128 kilometers, and its greatest width, from east to west, is about 118 kilometers. The geographic area of the district of Hassan is 6845 square kilometers (Figure 1).

2.2. Methodology

In the present study, various factors such as age, level of education, family size, gender, knowledge, participation, annual income, and attitudes were considered independent variables. The impact of pollutants from rice mills on the ecological system, agriculture, and human health were selected as dependent variables. A revised list of rice environment mills was obtained from Rice Mill Malik Somite[6]. In Hassan City, approximately 10 rice mills were identified, five of which were randomly selected. These selected rice mill operators and nearby household members constituted the study population. The study employed a multi-stage random sampling approach within the study area. Data were collected in person from various locations at varying distances from these mills (0,1.5, and 10 kilometers). A total of 94 respondents were selected as the sample using a random sampling procedure. Upon collection, the data were recorded on a coding sheet, and subsequently compiled, tabulated, and analyzed. Additionally, all qualitative data were transformed into quantitative format using appropriate scoring techniques to facilitate analysis.

In this research, the independent variables, including age, education, family size, farm size, gender, organizational participation, annual income, knowledge, and attitudes, were chosen to examine their influence on three dependent variables, namely environment, agriculture, and human health. To quantify respondents' age, the actual years from birth to the time of the interview were recorded, assigning a score of one for each year of age. For instance, respondents falling within the age range of 26-28 years were given a score of 26. Education was quantified based on the complemented formal level of education. Respondents who had passed the final examination of class two were

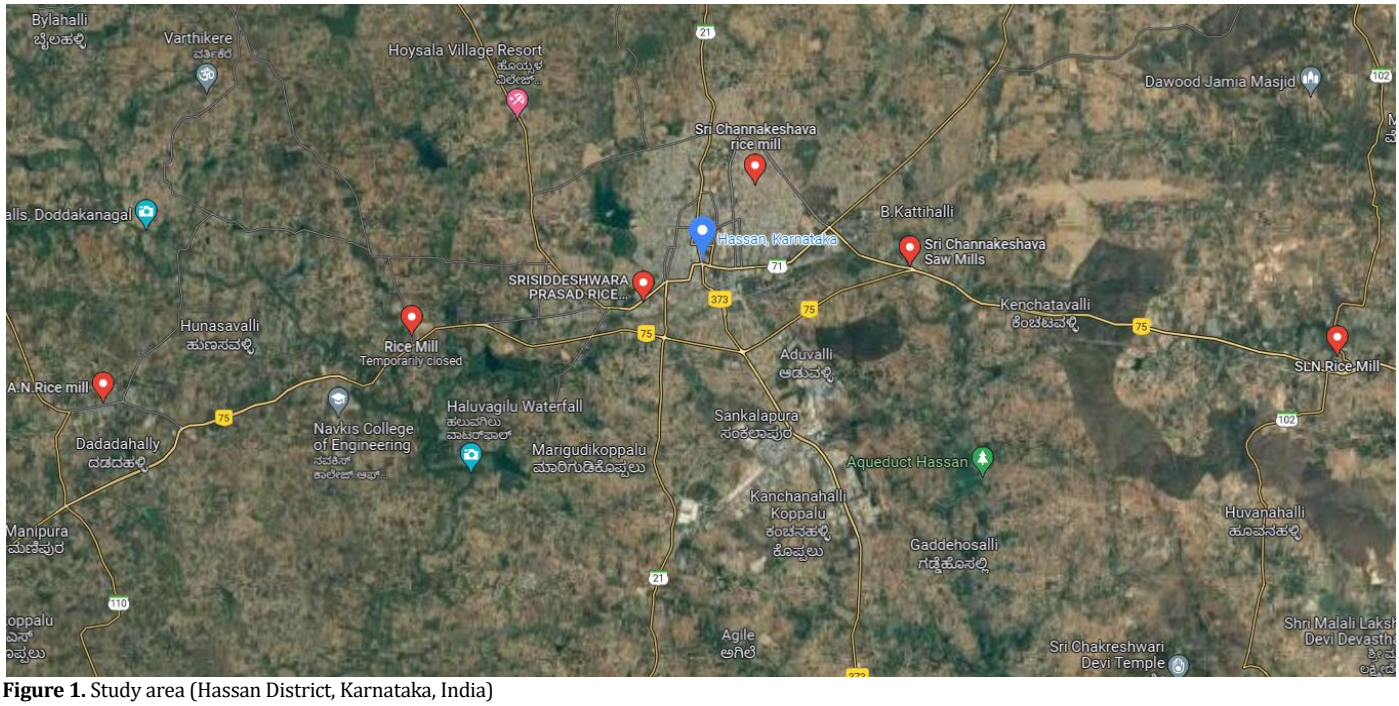

Figure 1. Study area (Hassan District, Karnataka, India)

assigned a score of two. Those with education outside the formal system were converted into class equivalents and scored accordingly. Individuals who could only sign received a score of 0.5, while the illiterate participants were given a score of zero.

Family size was determined by counting all members of the respondent's family, including themselves, their spouse, children, siblings, parents, and other dependents. Each family member was assigned a score of one, resulting in the total family size score. Annual income was measured in taka, encompassing earnings from farming, livestock, fisheries, and other sources like business or service. To assess the knowledge of rice mill workers, we developed a 10-question knowledge scale. Each question carried a value 2 points, with a maximum total score of 20, indicating comprehensive knowledge of rice mills.

Respondents' attitudes towards rice mills were evaluated using eight statements, including both positive and negative viewpoints. Positive statements were rated on a scale of strongly agree (4 points) to strongly disagree (0 points). Negative statements used a reverse scoring method, with strongly disagree rated as 4 points and strongly agree as 0 points. The sum of scores for all statements determined each respondent's attitude score, which could range from 0 to 30. A score of 0 indicated a highly unfavorable attitude towards rice mills, while 30 reflected a highly favorable attitude.

Respondents' evaluations of the impact of rice mill pollution on the nearby environment were assessed on a scale ranging from 0 to 40, with 0 representing very low impact and 40 signifying a high impact of rice mill pollution on the nearby environment. This evaluation was conducted through a questionnaire, where a score of 4 was assigned to strongly agree, 3 for agree, 2 for undecided, 1 for disagree, and 0 for strongly disagree when the statement was affirmative. Each respondent's final score for this variable was the sum of their individual scores. Similarly, the impact of rice mill pollution on nearby agriculture was also evaluated using a questionnaire, following the same scoring system. Again, scores could range from 0 to 40, with 0 indicating very low impact and 40 indicating a high impact on nearby agriculture.

To gauge the impact of rice mill pollution on nearby human health, a set of 10 questions was used, and respondents' scores were calculated in the same manner as before. The scoring system remained consistent across all variables, with 0 denoting very low impact and 40 signifying a high impact on nearby human health. Data collection was facilitated through an interview schedule, which was thoughtfully designed in alignment with the study's objectives. This interview schedule featured a combination of open-ended and closed-ended questions. Given the specific characteristics of rice mills under consideration, straightforward and clear questions were incorporated to gather the necessary information.

Before finalizing the interview schedule, it underwent a pre-test to identify any needed corrections, alterations, or adjustments. Once refined, the interview schedule was produced in its final form and used for data collection. Interviews with household heads were conducted in the Bengali language to ensure effective communication. To maintain the data's quality, close supervision of enumerators was maintained throughout the data collection process. This rigorous approach aimed to ensure the reliability and accuracy of the collected data.

2.3. Statistical analysis

The data were entered into the computer for statistical analysis, utilizing the SPSS version 16.0 (SPSS Inc., Chicago, IL) software. Various descriptive statistical measures, including frequency, number, percentage, age, mean, and standard deviation, were employed to categorize and describe the variables. Additionally, graphs and tables were utilized to aid in the findings.

3. Results and Discussion

3.1. Annual income

According to the data in Table 1, the findings indicated that the largest portion of respondents, accounting for 30.77%, fell into the high-income category, whereas 26.92% reported a medium income. Additionally, 23.08% of respondents reported a very high income, 11.54% had a low income, and 7.69% reported a very low income. Higher-income levels motivate individuals to strive for improved performance and showcase their elevated societal status.

3.2. Participation

Respondents' scores for organizational participation ranged from 1 to 20, within a potential range of 0 to 30. The average score was 12.46, with a standard deviation of 4.34. Based on these observed scores, the respondents were categorized into three groups, namely low (scores between 5 and 11), medium (scores between 12 and 18), and high participation (scores above 18). Table 2 displays the distribution of respondents according to their levels of

Table 1. Participants based on their yearly earnings in Hassan district, Karnataka, India, from January to June 2023

Classifications on Yearly earnings	Respondents		Range		Mean	Standard deviation
	Number	%	Min	Max		
< 15,000	8	8				
15,000 – 25,000	12	12				
26,000 – 50,000	28	28	10	110	62.52	25.13
51,000 – 75,000	30	30				
>75,000	22	22				
Total	100	100				

Table 2. Participation breakdown of survey respondents from January to June 2023

Classifications on respondents	Respondents		Range		Mean	Standard deviation
	Number	%	Min	Max		
< 5 - 11	34	34				
12 - 18	48	48				
>18	18	18	5	22	12.46	4.34
Total	100	100				

organizational participation.

3.3. Awareness of rice mills

The respondent's knowledge regarding rice mill operations was assessed on a scale ranging from 1 to 20, with observed scores falling within the 4 to 19 range. The average knowledge score was calculated at 11.46, with a standard deviation of 2.82. Based on these observed knowledge scores, respondents were categorized into three groups, including those with poor knowledge (scores between 4 and 9), those with moderate knowledge (scores between 10 and 15), and those with adequate knowledge (scores above 15). The distribution of respondents according to their knowledge categories is presented in Table 3.

Table 3 illustrates that most respondents fell into the moderate knowledge category, comprising 58.65% of the total. The adequate knowledge category accounted for 25.00%, while the poor knowledge category represented 16.35%[7]. This distribution aligns with the findings of a similar study, where the moderate knowledge category also constituted the largest portion at 38.89%, followed by the poor knowledge category at 31.11%.

3.4. Perceptions regarding rice mills

The respondents' scores for their attitude towards rice mills varied between 8 and 30, within a potential range of 0 to 30. The average attitude score was 15.42, with a standard deviation of 4.29. Based on these scores, respondents were categorized into three groups, including those with a low favorable attitude (scores between 8 and 15), a medium favorable attitude (scores between 16 and 23), and a high favorable attitude (scores above 23). The distribution of respondents' attitudes towards rice mills is presented in Table 4. The data revealed that 50% of the respondents held a low favorable attitude towards rice mills, while 33.68% displayed a medium favorable attitude, and only 16.32% exhibited a high favorable attitude. These findings align with a previous study (Hera AEM (2017), which also reported that nearly half (47.25%) of the workers had a low favorable attitude toward rice mills.

Table 3. Classifying respondents based on their familiarity with rice mills from January to June 2023.

Classifications on awareness	Respondents		Mean	Standard deviation
	Number	%		
4 – 9	15	15		
10 – 15	60	60		
>15	25	25	11.46	2.82
Total	100	100		

3.5. Influence of rice mill pollution on agriculture

The respondent's opinions regarding the impact of the rice mill were assessed at four distances from these mills (0,1,5, and 10 kilometers). The observed opinion scores varied between 8-47, 9-47, 9-47, and 20-47, respectively, against a potential score range from 0 to 40. These scores collectively represented the respondents' assessments of the rice mill's impact on agriculture. Based on these observed scores, the respondents were categorized into three groups: low impact (>20), medium impact (20-30), and high impact (above 30). The distribution of respondents based on their perceptions of the rice mill's impact on agriculture has been visually depicted in Figure 2.

3.6. Impact of rice mills based on distance

The impact of rice mills on the environment, agriculture, and health status at different distances was measured based on the opinion score of the respondents. These scores reflected the respondents' perceptions regarding the changes in three dimensions of environment, agriculture, and health status due to the presence of rice mills in their vicinity[8]. Regarding respondents' opinions on rice mill pollution, the observed scores at 0 m, 100 m, 500 m, and 1000 m distances was within a range of 8-47, 9-47, 9-47, and 20-47, respectively. This range fell within a possible score range of 0 to 48. The total score represented the impact of rice mills on the environment. Based on these

Table 4. Distribution of respondents according to their Perceptions Regarding Rice Mills from January to June 2023

Classifications on awareness	Respondents		Mean	Standard deviation
	Number	%		
8 – 15	50	50		
16 – 23	34	34		
>23	16	16	15.42	4.29
Total	100	100		

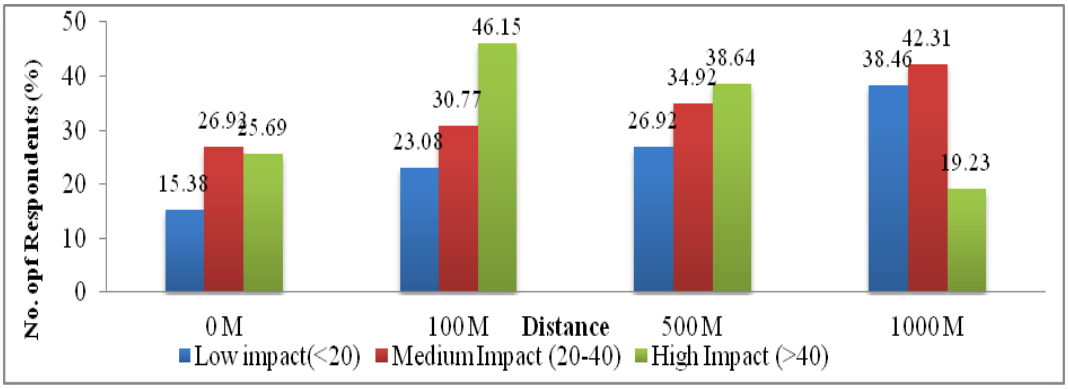

Figure 2. Allocation of the respondents as per the impact of rice mill towards agriculture at distances of 0 m, 100 m, 500 m, and 1000 m from January to June 2023

observed scores, the respondents were categorized into three groups, namely. low impact (> 20), medium impact (20-40), and high impact (above 40). The distribution of the respondents according to the impact of the rice mill on the environment is graphically presented in Figure 3.

3.7. Rice mill pollution impact on health

Regarding the impact of rice mills, the observed opinion score of the respondents at 0, 1, 5, and 10km ranged from 8-47, 9-47, 9-47, and 20-47, respectively, against the possible range from 0 to 48. These scores were used to assess the impact of rice mills on the health status of respondents. Based on these scores, respondents were categorized into three categories, namely low (>20), medium (20-40), and high impact (above 40)[9]. The respondents' responses regarding the impact of rice mills on health are graphically shown in Figure 4.

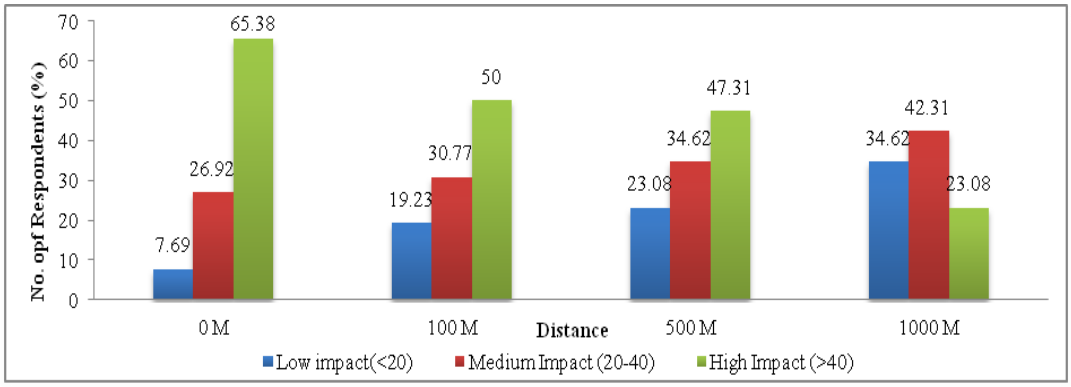

Figure 3. Allocation of the respondents as per the impact of rice mill on the environment at distances of 0 m, 100 m, 500 m and 1000 m from rice mill during January 2023 to June 2023

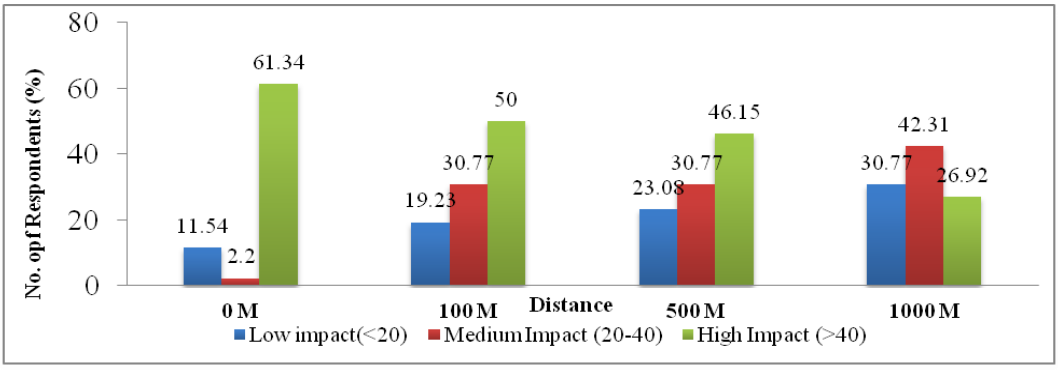

Figure 4. Allocation of the respondents as per the impact of the rice mill towards health at distances of 0 m, 100 m, 500 m, and 1000 m from rice mill during January to June 2023

4. Conclusion

Based on the aforementioned findings, it can be concluded that the introduction and establishment of rice mills in a region can yield enhanced economic advantages for the local population. However, this development also

entails numerous environmental, agricultural, and health-related challenges. To be more precise, the presence of a rice mill, particularly in the vicinity of Hassan City and its surroundings, has had adverse effects on the environment, agriculture, and the well-being of the nearby residents. The pollution impact on both agricultural productivity and human health was most severe within a radius of 100-500 meters from the mill site, progressively diminishing as the distance increased. Therefore, the current research strongly recommends that rice mills should be located at a minimum distance of over half a kilometer from human settlements and cultivable land to mitigate the potential pollution hazards associated with the rice mill industry.

Declarations

Competing interests

There was no conflict of interest.

Authors' contributions

Arpitha H R collected data by conducting experiments. Suresh B designed the study methodology and performed the statistical data analysis and the literature reviews. Suresh S guided on data analysis and interpretation of results findings, literature search, and previews. All authors read, substantially revised, and approved the final manuscript.

Funding

The authors received no financial support for the publication of this article.

Availability of data and materials

All data related to the present study will be available upon the reasonable requests from authors.

Ethical considerations

The authors verified the absence of plagiarism and provided their consent for the article's publication. Additionally, they conducted a thorough examination of the article to ensure there was no data fabrication, double publication, or redundancy.

Acknowledgments

The authors extend their utmost appreciation to HB Aravinda Principal, Bapuji Institute of Engineering and Technology, for their ethical research approval. The authors are also deeply thankful to the dedicated enumerators and the family members from Hassn City, whose valuable contributions played a pivotal role in ensuring the success of this research survey.

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