

**ORIGINAL RESEARCH ARTICLE****Assessment of grain dust management systems among selected animal feed manufacturers in Kiambu County, Kenya****Virginia Kimanzi¹, Charles M. Mburu¹ Paul M. Njogu¹***1Institute of Energy and Environmental Technology, Jomo Kenyatta University of Agriculture and Technology (JKUAT), P.O BOX 62000-00200, Nairobi, Kenya*Corresponding email: virginiakimanzi@gmail.com**ABSTRACT**

The animal feed industry in Kenya has experienced rapid growth due to the increased demand for animal feed around the major towns. That equally increased the risks of exposure to grain dust among the workers. The level of awareness about the risks and the existing control measures has not been adequately studied and documented in Kenya. The overall objective of the study was to assess the dust management systems among selected animal feed manufacturers in Kiambu County, Kenya. The study adopted a cross-sectional study design. A total of 355 animal feed mill workers were sampled using Yamane's formula. They assessed the dust management systems using structured questionnaires, interviews, and walk-through surveys. SPSS was used to process and analyze the collected data. The results showed that the majority of the workers had not been trained in the elements of grain dust management. None of the workers was aware of the air sampling measurements or the exposure limits. Only 16.13% of the feed millers controlled the dust using other engineering and administrative controls apart from ventilation. The study concluded that there was a need for improvement in dust management measures among the facilities and the workers. The study recommends improvement in the dust control measures whereby the workers should adhere to the set safety and health guidelines and the management of the animal feed manufacturers should provide continuous training, suitable gear, and development of engineering controls to minimize the exposure to grain dust.

Keywords: Ventilation, Personal Protective Equipment, administrative controls, exposure limits**1.0 Introduction**

Globally, diseases linked to occupation-related factors account for approximately 4–10 million cases per year, whereas an estimated 3–9 million cases are reported in developing countries per year (Tulchinsky and Varavikova, 2014). Occupational exposures to grain dust account for approximately 12% of deaths linked to chronic obstructive airway diseases (Iyogun, Lateef, and Ana, 2019). This may be a result of the pathogenic response of victims to their occupational environments as a result of prolonged exposure to allergens that are present in grain dust, resulting in acute or chronic respiratory ailments (Karpinski, 2003). There exists sufficient documentation of the respiratory health effects on workers exposed to various dust



particles in their respective occupational environments during the production processes (Meo and Al-Drees, 2005; Subbarao, Mandhane and Sears, 2009; Mohammadien, Hussein and El-Sokkary, 2013). It is acknowledged that limited research and documentation on the same exist in developing countries, including Kenya, which is attributed to poor record-keeping of occupational diseases and non-existent health surveillance systems (Aiguomudu, 2018).

Feed mill workers are potentially exposed to grain dust that may adversely affect their respiratory health (Musa *et al.*, 2000). Researchers have attributed the increase in the prevalence of respiratory symptoms and lung function impairment in various work environments to exposure to grain dust (Elms *et al.*, 2003; Bulat *et al.*, 2004; Abbasi, Ahsan and Nafees, 2012; Mohammadien, Hussein and El-Sokkary, 2013; Aiguomudu, 2018). These studies have highlighted the significance of grain dust exposure in the animal feed industry. The exposure and the subsequent health disorders have contributed to decreased productivity in feed mill workers. Some of the predisposed workers suffer from exacerbated respiratory health disorders, which cost the individual in medical expenses and, more broadly, the organizations in hospital bills, insurance, compensation claims, and lost work hours.

Kenya has experienced steady growth in the animal feed industry. The national production is projected to be between 0.76 and 1.02 million metric tonnes in 2020 (Auma *et al.*, 2018). This is linked to the increased demand for animal feed around major towns, leading to an increase in unregulated animal feed mills (Lukuyu *et al.*, 2011; Omanga *et al.*, 2014). Kiambu county borders major urban centres where demand for animal products, including milk, meat, and eggs, is very high. This implies that animal production is extremely intensive, which has subsequently attracted many unregulated feed mills to set up production units in the country. This has resulted in increased risks of occupational and health-related impacts arising from poor implementation of regulations such as The Occupational Safety and Health Act, 2007 and The Factories and Other Places of Work Act (Hazardous Substances) Rules, 2007, lack of awareness and low personal protective equipment usage among workers (Omanga *et al.*, 2014). Private ownership of most animal feed mills, where a large proportion of them are small-scale, has resulted in the industry focusing more on business continuity and less on regulatory obligations such as health and safety standards in the workplace (Kenya Markets Trust, 2016). This exposes the workers to grain dust, whose consequence is the eventual development of occupation-related illness. This is higher in small-scale mills in developing countries due to poor enforcement of occupational health and safety standards, use of older technology, poor working environment, lack of awareness of potential health hazards, and lack of use of personal protective equipment (Iyogun, Lateef, and Ana, 2019). The first step in the adoption and enforcement of the occupational health and safety standards would be the assessment of the workplace environment and workers' awareness to evaluate the effectiveness and efficiency of the grain dust management systems in preventing and controlling grain dust exposure to animal feed workers. Consequently, it should be noted that most occupational exposures can be reduced or eliminated through engineering controls and the use of personal protective equipment, which are absent in most animal feed mills in developing countries (Aiguomudu, 2018). This study is aimed at assessing the current grain

dust management systems among selected animal feed manufacturers in Kiambu County, Kenya.

2.0 Materials and methods

2.1 Study design

This study adopted a cross-sectional research design as a starting point with a recommendation for a longitudinal study.

2.2 Study population size and area

Kiambu County covers an estimated area of 2,543.5 km² within the central Kenya region, with most animal feed manufacturers located in Thika's industrial zone as per figure 1. It had 3,136 workers from 35 registered feed milling manufacturers duly recognized by the Association of Kenya Feed Manufacturers (AKEFEMA).

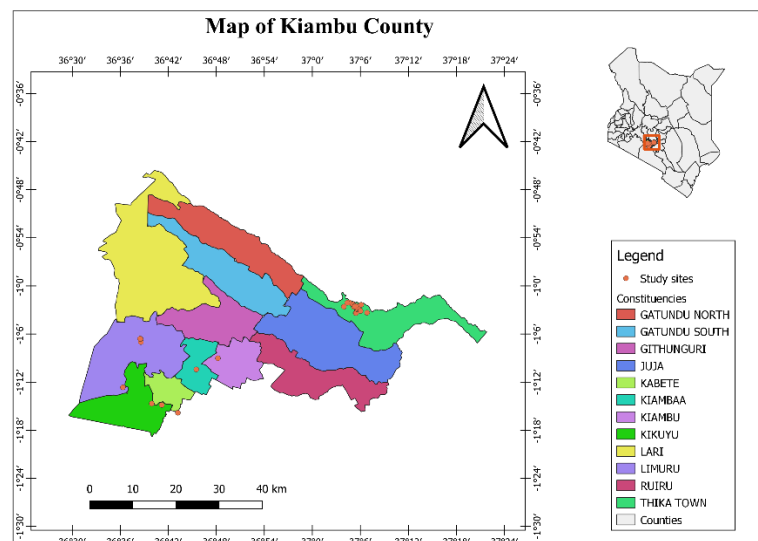


Fig. 1: Map of the study area

A total of 355 respondents formed the sample size from which inferences from the population were drawn. The number was based on Yamane's formula,

$$n = \frac{N}{1 + N(E)^2}$$

where n was the sample size, N was size of population, and E being set 0.05 implying a 95% confidence level.

2.3 Data collection methods

A modified British Medical Research Council questionnaire (Medical Research Council Committee on the Aetiology of Chronic Bronchitis, 1960) was used to collect data from the



target respondents. The questionnaires were based on both open-ended and closed-ended questions, which addressed specific research questions for this study. The questionnaire used in this study was divided into two sections. The first section captured socio-demographic information about the population, such as gender, age, designation, and work experience. The second section gathered information on the practices and respiratory health of the workers. The participants were requested to respond based on their knowledge of existing rules and regulations regarding occupational safety and health; the existence of safety and health systems within the workplace; and their respiratory health assessment. The questionnaires offered anonymity, thus encouraging the respondents to answer. A walk-through survey was conducted through the business unit to record the existing working conditions and to corroborate the findings on the workers' safety and health practices. This was done using an observation checklist that took into account direct observations of the safety risks, safety controls, and use of personal protective equipment. Further, interviews were used to obtain data from the senior management about the company's profile to support the survey findings.

2.4 Data Analysis and Presentation

Before the analysis, all questionnaires were checked for incompleteness, duplication, and inconsistencies. Firstly, the data collected was edited and coded to get the relevant data for the study. Quantitative data collected from questionnaires and observation checklists were analysed using descriptive statistics using SPSS (Statistical Package for Social Sciences) and presented as percentages and frequencies. The study's statistical significance level was at $p < 0.05$ or a 95% confidence level.

3.0 Results

3.1 Response rate

A total of 292 questionnaires were duly filled out by the respondents from the 355 questionnaires administered by the interviewers. This was an 82.25% response rate. Mugenda and Mugenda (1999) state that a response rate of 50% is adequate for statistical reporting.

3.2 Socio-demographic characteristics of the respondents.

Table 1 presents the results of the socio-demographic data of the respondents

Table 1 Socio-demographic characteristics of the respondents

Characteristics	Frequency	Percentage
Gender		
Male	258	88.36%
Female	34	11.64%
Age group (years)*		
18-29	170	58.22%
30-39	91	31.16%
40-49	21	7.19%
50-59	10	3.42%
Level of education		
Primary	57	19.52%
Secondary	140	47.95%
Tertiary	95	32.53%
Years of experience in the animal feed industry		
Less than 1 year	51	17.47%
1-5 years	159	54.45%
6-10 years	61	20.89%
11-15 years	15	5.14%
16 years and above	6	2.05%
Job role/department		
Administration	59	20.21%
Machine operator/attendant	195	66.78%
Engineer	4	1.37%
Manager/Supervisor	34	11.64%
Smoking history		
Smokers	23	7.88%
Non-smokers	265	90.75%
Ex-smokers	4	1.37%

*Mean (\pm SD) of the age group: 30.54 (\pm 7.397) years

There were more males in the study than females, comprising 88.36%. The respondents within the age group 18-29 were the highest in number, followed by the age group 30-39, and 10.5% were comprised of age groups 40-49 and 50-59, with a mean age of 30.54 years. Approximately half of the respondents had completed secondary school education (47.95%), while nearly a fifth had primary school education (19.52%), and more than a third had tertiary education (32.53%). More than half of the respondents (54.45%) had between one and five years of

experience, while those with six years or more of work experience accounted for 28.08%. Two-thirds of the respondents were machine operators or attendants classified as operational-level employees (66.78%). The middle-level employees comprised a fifth of the respondents, including the administration (20.21%) and the engineers (1.37%). The management, who were managers or supervisors, consisted of 11.64% of the respondents. A few respondents (7.88%) were current smokers.

3.3 Dust management system measures implemented at the animal feed mills.

Table 2 shows the results of the reported dust management control measures at the animal feed companies in Kiambu County.

Table 2 Reported dust management control measures at the animal feed companies in Kiambu County, Kenya

Dust management control measures	Frequency			
	N	%	N	%
	Yes		No	
Availability of dust management policy statement	4	1.37%	288	98.63%
Availability of dust management system or program	38	13.01%	254	86.99%
Work injury Benefit Act (WIBA) insurance policy awareness by the workers	92	31.51%	200	68.49%
Training on safe dust management procedures and rules	48	16.44%	244	83.56%
Training on the grain dust hazards	10	3.42%	282	96.58%
Air sampling measurements to determine the exposure to dust	0	0.00%	292	100.00%
Awareness of the exposure limits to the grain dust within the scope of the work	0	0.00%	292	100.00%
Availability of the safety signs indicating highly dusty areas	4	1.37%	288	98.63%
Training on the usage of the Personal Protective Equipment (PPE)	40	13.70%	252	86.30%
Provision of the Personal Protective Equipment (PPE)	8	2.74%	284	97.26%

The percentage availability of both dust management policies and systems to the workers was less than 15%. On WIBA insurance awareness, 31.51% of the workers were aware of it. The proportion of workers trained on dust management procedures was 16.44%, grain dust hazards (3.42%) and usage of PPE (13.70%), showing that the vast majority were not trained. None of the workers was aware of the air sampling measurements or the exposure limits. The percentage of workers who were aware of the available safety signage was 1.37%. Only 2.74% of the workers reported having been provided PPE by their companies.

Table 3 presents the observed Dust management control measures at the animal feed companies in Kiambu County.

Table 3 Observed dust management control measures at the animal feed companies in Kiambu County, Kenya.

Dust management control measures	Frequency			
	N	%	N	%
	Yes		No	
Fully operational ventilation systems	22	70.97%	9	29.03%
Segregation of work processes	5	16.13%	26	83.87%
Structural dust controls (manual or automated) apart from ventilation systems	5	16.13%	26	83.87%
Warning signs indicating a hazardous atmosphere	0	0.00%	31	100.00%
MSDS for production inputs and outputs	0	0.00%	31	100.00%
Workspaces free from dust	0	0.00%	31	100.00%
Obstructions near the air inlets and outlets within the workplace	16	51.61%	15	48.39%
Sources of air contaminants within the workplace	31	100.00%	0	0.00%
Visible mould on the raw materials and finished products	0	0.00%	31	100.00%
Shaking the bags during emptying	31	100.00%	0	0.00%
Workers tipping the bags into the feeding inlet while facing away	31	100.00%	0	0.00%
Dust stirred during cleaning	31	100.00%	0	0.00%
Workspaces cleaning during the production in case of spillages	5	16.13%	26	83.87%
Routine cleaning schedules for the production floor	5	16.13%	26	83.87%
Workers wearing dust protective gear such as masks and respirators properly during all production processes	0	0.00%	31	100.00%

70.97% of the animal feed production facilities had some form of general and local exhaust ventilation, with no visible mould on the raw materials and finished products in the 31 millers. Despite this, there was no animal feed millers' workspace that was free from dust. In furtherance, none of them had warning signage and Material Safety Data Sheets (MSDS) for the inputs and products. Only 16.13% of the feed millers controlled the dust using other engineering and administrative controls such as segregation of the work processes, structural dust control systems such as dust collectors, and routine cleaning procedures. Workers in all mills tipped the bags into the feeding inlet while facing away and shook the bags when emptying them, stirring dust in the surrounding air. During the cleaning process, dust was



generated in all the milers. More than half of the workplaces had obstructive objects near the air inlets and outlets within the workplace. It was observed that no worker wore the dust protective gear properly.

4.0 Discussion

There were more males in the study than females, which is attributable to the high level of physical labor involved. It can be deduced that this sector is male-dominated. This study finding is consistent with the results of Straumfors et al. (2016) on the cross-shift respiratory response to bioaerosol exposure of grain dust, where the male respondents were 94% while the female respondents were 6%.

There were high literacy levels among the respondents, which could be used as an opportunity by the management of the animal feed facilities to provide continuous training to improve their workers' knowledge of the dust control measures. This study finding is not consistent with the findings by Tosho et al. (2015) on the prevalence of respiratory symptoms and lung function of the flour mill workers in Ilorin, Nigeria, which showed that 26.7% of the workers had no formal education, 0.9% attended primary school, 11.9% went to secondary school, and 36.6% had tertiary education. The disparity is a result of the study focusing on flour mill workers and the differing adult literacy rates between Kenya (78%) and Nigeria (59.6%) (UNESCO, 2013).

The majority of the respondents had between one and five years of experience, implying that there was a high personnel turnover ratio that would amplify the healthy worker effect and reduce the animal feed facilities' capacity to retain workers with good knowledge of and practices for the dust control measures. This study finding varies with the results of the studies in Nigeria by Iyogun et al. (2019) and Tosho et al. (2015), attributable to the differing labour markets in Kenya and Nigeria. Iyogun et al. (2019) reported that about 75% of the grain miller workers had worked for more than 5 years, whereas Tosho et al. (2015) found that 55.4% of the flour mill workers had worked for more than 5 years.

The majority of the workers were neither trained nor aware of the various elements of dust management procedures, which increases the risk of occupational diseases or other effects related to grain dust exposure. Continuous training is needed in promoting a safety culture within the workplace. These study findings were supported by a study conducted in bakeries located in the United Kingdom where 40% of the fifty-five bakeries conducted some form of training on flour dust to employees during their job orientation, and 27% of the bakeries were aware of the occupational exposure limits (Elms *et al.*, 2005).

Very few workers reported having been provided with PPE by their companies, and where the PPE was available or self-provided, there was no worker who wore the dust protective gear properly. The importance of PPE is very vital since it is the last resort when minimizing the exposure to grain dust. This was consistent with the study conducted by Adeoye et al. (2015) to evaluate the awareness of occupational hazards among sawmill workers in Osun State,

Nigeria. The study findings were that employers rarely provided them, and when they did, they were not long-lasting. The study findings on low and improper usage of PPE were similar to a study conducted by Kayode (2010) that sought to assess the awareness of work-related hazards and safety measures. This was done in Ilorin, Nigeria, involving 257 workers from eleven sawmill factories where less than 20% of the workers wore protective gear. Similar findings were observed by Adeoye et al. (2015), whose study was to evaluate the awareness of occupational hazards among sawmill workers in Osun State, Nigeria. It was observed that the reported usage frequency of personal protective equipment was nil except for facemasks, gloves, and goggles, whereby the percentage of the workers using them frequently was 2%, 5%, and 10%, respectively. This low usage was attributed to non-availability (Adeoye *et al.*, 2015). In addition, low usage may be attributed to the health belief model, where workers might only take action when they perceive a hazard to cause harm or injury to them (Rosenstock, 1974). According to the Occupational Safety and Health Act, 2007, employers have to ensure they provide protective gear for their workers within the workplace. If this is done accordingly, it can help in reducing exposure levels to workers.

70.97% of the animal feed production facilities had some form of general and local exhaust ventilation with no visible mould on the raw materials and finished products in the 31 millers. This shows that there is a general compliance within the animal feed sector in the provision of proper ventilation systems as required by the Occupational Safety and Health Act, 2007. These study findings were comparable with the study done by J. Elms et al. (2005) evaluated the control measures of fifty-five bakeries in England, Scotland, and Wales. It was observed that 86% of them had a certain kind of mechanical ventilation, with 28% having local exhaust ventilation (Elms *et al.*, 2005). Despite this, there was no animal feed millers' workspace that was free from dust.

None of the millers had warning signage or Material Safety Data Sheets (MSDS) for the inputs and products. This contravenes the Occupational Safety and Health Act, 2007 and the Factories and Other Places of Work Act (Hazardous Substances) Rules, 2007 that state that the employer shall make available MSDS for all hazardous substances into which the grain dust falls.

Only 16.13% of the feed millers controlled the dust using other engineering and administrative controls such as segregation of the work processes, structural dust control systems such as dust collectors, and routine cleaning procedures. This is because the initial cost of setting up the engineering controls is higher as compared to the administrative controls. This causes the management of the animal feed facilities to be reluctant about installing them and focus on profit maximization. These study findings were similar to those observed in the study conducted to assess the control measures among bakery workers in Edo Central Senatorial District, Nigeria, where structural controls and local exhaust ventilation were scarcely available (Aiguomudu, 2018).



5.0 Conclusion

The majority of the workers had not been trained in dust management techniques such as dust management procedures, grain dust hazards, and the use of PPE. The majority of the workers reported having not been provided with PPE by the companies. Though the majority of the workers self-provided their PPE, it was observed that no worker wore the dust protective gear properly.

The majority of the animal feed production facilities had some form of general and local exhaust ventilation, although there was no animal feed millers' workspace that was free from dust. Only 16.13% of the feed millers controlled the dust using other engineering and administrative controls such as segregation of the work processes, structural dust control systems such as dust collectors, and routine cleaning procedures. Thus, there was a need for improvement in dust management measures among the facilities and the workers.

6.0 Recommendation

Workers should be provided with ongoing training and appropriate protective equipment by animal feed mill companies. Additionally, they should improve the existing control measures for grain dust and develop appropriate control measures where none exist. On the other hand, the workers should adhere to the set safety and health guidelines and wear the appropriate personal protective equipment at all times. This will promote awareness of the grain dust hazards and help stimulate a safety and health culture. This is per the Occupational Safety and Health Act, 2007 and The Factories and Other Places of Work Act (Hazardous Substances) Rules, 2007.

7.0 Acknowledgments

7.1 Funding

None

7.2 General acknowledgement

The researcher ensured that the potential respondents were not coerced into taking part in this study. The principle of voluntary participation was followed by ensuring informed consent was obtained from the feed mill workers and managers. The researcher guaranteed the participants' confidentiality by assuring them that the information provided was used only for academic purposes.

7.3 Declaration of interest

This article has been approved by the ethics committee at Jomo Kenyatta University of Agriculture and Technology (JKU/2/4/896B) and a research license from the National Commission for Science, Technology, and Innovation (NACOSTI) granted by the Kenyan authorities.



7.4 Conflict of interest

None.

8.0 References

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