Ergonomics in small-scale grain mills in Nigeria

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NIGERIA

Introduction
Nigeria, the most populous country in Africa (about 120 million) is essentially agrarian in nature with over 80 per cent of her food needs being produced by peasant farmers cultivating, in many cases, less than 2 hectares of land. Among the major crops produced and consumed in large quantities are sorghum, millet, maize, rice, cassava, and yam. The inhabitants of each region of the country can be identified by having at least one of these crops as their major food. For example, grains are consumed in the far north, while in the southern part of the country, tubers are the main food.

However, the crops are subjected to different processes before they are ready for consumption. One such process is the conversion of the grains or the chips (in the case of cassava and yam) into flour (size reduction). Some decades ago, this operation was done using stones. Today, as a result of mechanization of agriculture and advancement in technology generally, there are tools and machines for performing this operation.

Although the country has a few large-scale industries (flour mills), the size reduction process in most cases is done at the small-scale (sometimes at family) mills using hammer or burr mills (Photo 1). The capacity of such mills can be as low as 20kg/h and as high as 100kg/h. These mills are of different makes and designs. They are equally housed in structures made of different materials and with different sizes and designs. Casual observation of the mills shows that they are noisy and may be hazardous to the operators and clients.
No study has so far been conducted to ascertain the extent of this problem. This study is therefore aimed at assessing the ergonomic characteristics of these mills in view of their importance to the Nigerian population, with a view to making appropriate recommendations for improvement in their design and operation.

**Ergonomics**

Etymologically, the term originates from two Greek words, *ergon* meaning work and *nomos* meaning law. Ergonomics is, therefore, the study of law(s) governing work and its environment. Ergonomics includes human factors in engineering and it deals with the consideration of human characteristics, expectations, and behaviours in the design of tools, equipment, etc. that people use in their work and everyday lives and the environment in which they work and live.

The present trend in agricultural mechanization requires that attention be focused on the need to consider human beings in the design and modification of machines and devices in order to make the goals of mechanization achievable. In line with the goals of mechanization, efforts have been and are being made to adapt machines and the environments in which they are operated to suit human health, safety and comfort.

Technology is a mixed bag in that it can contribute either to the improvement or to the detriment of our lots in life, depending on how, when and where it is applied. The machines used for smallscale milling of grains are usually operated by men. Therefore, the man-machine system should be one that encourages human values, such as good health, safety and comfort during operation.

**Ergonomic factors defined**

The central focus of ergonomics relates to the consideration of human beings in carrying out such functions as the design and creation of many objects, the development of procedures for performing work and other human activities, the provision of services to people and the evaluation of the materials people use in terms of their suitability for them. The objectives of ergonomic factors in these functions are two-fold: namely, to enhance the effectiveness and efficiency with which work and human activities are carried out; and to maintain or enhance certain desirable human values (e.g. health, safety, satisfaction). The central approach of ergonomic factors is the systematic application of relevant information about human abilities, characteristics, behaviour and motivation in the execution of such functions.

Human factors are of paramount consideration in developing farm machinery given that these machines will often be operated by persons with minimum skill and/or minimum understanding of the system (1, 2). Therefore, farm machinery should be made simple to operate and as free from hazards as possible.

**Materials and methods**

The study area is Minna, the Capital of Niger State, Nigeria, which is made up of two local government areas (LGA). Food crops produced are grains (sorghum, maize, and millet) and tubers (yam and cassava). These food crops are usually processed for immediate consumption, for storage and also for transportation to other parts of the country, and for export.

a) **The mills**

The functional mills in the two local government areas in Minna were visited and numbered. Ten mills were randomly chosen from each local government area. The mills selected were then assessed for ergonomic compliance. The parameters assessed include:

(a) Physical dimensions of the buildings housing the mills. These were measured with a measuring tape. The doors, windows, the space occupied by the engine(s) and other facilities were measured. The difference between the total area and the area occupied gives the workspace.

b) **Machine dimension**

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the machines were measured with reference to the floor, e.g. the hopper to the floor, the control to the floor, the starting control to the floor and the switch to the floor.

e) Sound
The sound produced was measured using a sound level meter placed close to the operator’s ear.

f) Other parameters
There is a number of other parameters, but these could not be measured directly. They include the amount of discomfort during operation and the effect of the level of congestion in the mills.

Results and discussion

Physical dimension of the building
The results show that the mill structures differed within and between the local government areas. It was also observed that mill structures were erected not on the basis of any standard, but on the basis of the available land within the area of interest; the installation of machinery was based purely on the owner’s preference. Many of the mills were found very close to highways, probably for ease of accessibility. Doors and windows were of different sizes and in some cases did not follow any architectural design. Furthermore, many of the windows were too small to provide the required ventilation.

Machine dimensions
The machines should be installed in a manner that guarantees easy reach to the hopper, the switch and the control without the operator overstretching his body.

Table 1 shows the dimensions considered critical to guarantee this need. The values would seem adequate since the operators do not have to stretch their bodies before reaching any of the positions. However, in some mills where operator’s seats were not provided, operators had to bend to reach the grain control wheel. Doing this intermittently for twelve hours a day, since some of them work that long, will constitute a health hazard.

Man-machine and human dimensions
The interaction between man, machine and the environment in which he works affects not only the efficiency of the system, but also the safety of operation. Using the centre of the seat as a reference point, the distances which the operator must reach during his work are shown (Table 2). All the dimensions but one are within the arm length for both the 5th percentile and 95th percentile of all subjects (Table 3). The above values are in conformity with human dimensions, as the operator operates his machine from his seat without overstretching himself.

Temperature
The lowest temperatures inside the mills for the critical period (12:00 noon to 3:30 pm) were 28–29°C, obtained at noon. Temperatures were the highest, 46–49°C, between 2:30 pm and 3:00 pm. Given that milling operation is a light operation done either standing or sitting, for which the recommended maximum workplace temperature is 24°C (3), the Nigerian small mill operators must be working under unhealthy and unacceptable conditions. Apart from the discomfort and health hazard experienced, efficiency is reduced at a workplace temperature of 27°C. The reduction in efficiency could be as much as 40–50% if the temperature reaches 30–35°C [Lehmann, 1966, as reported by Zalewski and Pleszczynski (3)].

Noise
The source of power in agriculture is associated mainly with the use of engine power and with static power driven machines. It has been established that exposure to an average noise level exceeding 80dBA over an 8-hour working day can damage hearing. It is difficult to establish the average levels when there are variations in noise during the exposure period. It is recommended, therefore, that all equipment should be designed to have noise levels below 80dBA at all times. If the noise cannot be reduced at the source, some type of protection should be provided for the operator (4).

Table 4 shows average noise levels measured at the operator’s ear in the twenty mills studied. The lowest noise level was 83.4 dBA while the highest was 110.3 dBA. The noise levels in the mills were thus higher than the recom-

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<th>Table 3. Human dimensions pertinent to the operation of mills</th>
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<th>Table 4. Average noise levels recorded at the studied mills</th>
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<td>Mills</td>
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LGA = local government ares
mended value. In some of the mills, communication was so hampered by the noise level that sign language became the mode of communication between the operator and the clients.

**General observation**

The environment of the mills studied was generally unhygienic and did not conform to standards for food processing industries. The floors and walls are not laid with tiles as required. Drives – i.e. belts and gears – are exposed, constituting danger to operators and clients. Black oil (used oil) is used for lubrication in some cases instead of grease (Photo 2).

**Conclusion**

The ergonomic study of small-scale mills reported here has shown that there are no standards for construction, installation, operation and maintenance in place in Nigeria. This is evident in the fact that make-shift structures are used without planning or design for safe and healthy operation. As a result, temperatures of 49°C and noise levels exceeding 80 dBA are commonplace in the mills. Similarly, the environment of mills is not hygienic, falling far below the standards of a food processing industry. There is a need to standardize the operation of the mills in terms of design of structure, required finishing, etc.

**References**


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