

Effect of noise and vibration on tractor operator during tillage operation under wet and dry field condition

ANISA, GEETA AND VISHAL KUMAR

Received : 26.08.2013; Revised : 24.10.2013; Accepted : 25.11.2013

See end of the Paper for authors' affiliation

Correspondence to :

ANISA

Shivdam Singh Institute of
Technology and Management,
ALIGARH (U.P.) INDIA
Email : anisa0987@gmail.com

■ **ABSTRACT** : Ergonomics is a scientific study of relationship between man and his working environment. Physical agents are forms of energy that can harm the body when exposure takes place. Physical working capacity diminishes with age and sex. In the same age and sex group also, there are individual variations due to the weight, nutrition etc. Experiment were conducted with five dependent variables *viz.*, body temperature, blood pressure, heart rate, noise and vibration level, and three independent variables *viz.*, tillage implement, operator age group and field conditions. The tractor operator having age group of 21-30 years was found minimum physiological changes as compared to 31-40 and 41-50 years age in all tillage operations. In wet field conditions the change in physiological responses and the effect of noise and vibration on tractor operator were minimum as compared to dry field conditions.

■ **KEY WORDS** : Noise, Vibration, Tillage operation, Tractor operator

■ **HOW TO CITE THIS PAPER** : Anisa, Geeta and Kumar, Vishal (2013). Effect of noise and vibration on tractor operator during tillage operation under wet and dry field condition. *Internat. J. Agric. Engg.*, 6(2) : 524-528.

Ergonomics (also known as human engineering) is still a new concept in Indian agriculture. It is necessary to create greater awareness about its contribution in improving the quality of life of workers and operators. The development of more complex machines and the increasing awareness about occupational health and safety aspect have made ergonomics and product safety the dominant consideration in design of tractors and farm equipment. It is important to know how to increase the efficiency of human power application in agricultural operation by utilizing ergonomic principles without jeopardizing the health and safety of the workers so as to get maximum benefits. India has emerged as the world's largest manufacturer of 30 to 45h.p. four-wheel farm tractor with its annual sale crossing 2,54,120 during 2004-05. India has now a population of over 2.0 million tractors operating in the farms and the farmers invest more than Rs.20, 000 crores annually in the farms of agricultural engineering inputs. Today the sale of tractor in the country is increasing steadily and use of tractor increased at a compound growth rate of more than 13% annually.

Physical agents are forms of energy that can harm the body when exposure takes place. They may be specific part of production process or an unwanted by products. Exposure to excessive noise, vibration, extreme temperature and

radiation can lead to acute or chronic health effect. Physical working capacity diminishes with age and sex. In the same age and sex group also, there are individual variations due to the weight, nutrition etc. When a person does physical work, he has to stop the work either due to cardio-respiratory limitations, muscular fatigue or others kinds of problems on his body parts (Saha *et al.*, 1979).

Noise is unwanted sound. Sound is a form of mechanical energy caused by the vibration of the air. The ear is a remarkable organ. The normal range of hearing begins at approximately 0 decibel, a level at which a person with excellent hearing is able to detect a sound. Typically, a person begins to identify sounds when a level of 10 to 15 dB is reached; this is the threshold of hearing. The other end of scale is known as the threshold of pain (140dB), or the point at which the average person experiences pain. In assessing noise, a special measure called "dba" indicates damage to hearing. The dba rating is provided for many pieces of agricultural equipment. The higher the dba number, the greater the risk of damage to hearing. Excessive noise has the potential to impair hearing, or even destroy it. Noise may also put stress on other parts of the body causing the abnormal secretion of hormones, the tensing of muscles and other health effect. Sleepless and fatigue are among the

symptoms. Noise also interferes with communication, which can affect normal function including job performance and safety. The specific health effect depends on the types of noise involved and the duration of exposure (Solecki, 1998).

Vibration is nothing but it is an oscillation of mass about a fixed point. When a body comes in contact with mechanical sources of vibration the tissues of the body become displaced from their resting position. Low frequency ride vibrations in tractor operation affect work output and operator health. Whole body vibration is transmitted to the body through the supporting surfaces such as the feet, buttocks or back. The health effect of whole body vibration on tractor driver are abdominal pain, general feeling of discomfort including headaches, chest pain, nausea, loss of equilibrium (balance), muscle contractions with decreased performance in precise manipulation tasks, shortness of breath, influence on speech, degenerative spinal change, lumbar scoliosis etc. (Dworecki *et al.*, 1998).

■ METHODOLOGY

Instrumentation used for the experiments, data collection and finding out the physiological responses study of extent of noise and whole body vibration on tractor operator during tillage operation under different field conditions. Methods adopted for analysis of experimental data have also been included in this chapter. Experiments were conducted at Central Institute of Agricultural Engineering Bhopal during the year 2012.

Selection of variables :

There were several possibilities of including dependent and independent variables for the study. Discussions on the inclusion of variables selected for the present study are given in the following section and subsection. Five dependent variables were studied to find out the effect of selected independent variables on them were body temperature, blood pressure, heart rate, noise and whole body vibration (WBV). Three independent variables *viz.*, were taken to find out the effect on tractor operator during tillage operation under different field conditions. The bulk density of the soil was 1.5-1.6 g/cm³ at dry condition and 1.3-1.35 g/cm³ at wet field conditions.

Procedure for collection of data :

All the physiological responses data were taken before and after commencement of work and all the data of noise and whole body vibration were taken during 1 hour of tillage operation under different field conditions. A 35 h. p. of new (<6 month used) model were also used for the study. The instrument and accessories used for the measurement of experimental data included a thermometer, blood pressure meter, stethoscope, sound level meter and vibration level

meter.

Procedure for measurement of body temperature :

It has been known for many years that skin temperature is a major factor in thermal comfort. The internal temperature is independent of skin temperature. The body temperature (°F) of tractor operator was measured by the Digital thermometer "Model-ECT-1" before and after commencement of each operation. The thermometer sensor head was put under the operator tongue and hold for some time, the thermometer gives the beep sound, means the temperature is measured and read the temperature in Fahrenheit (Milosevic, 1997).

Procedure for measurement of blood pressure :

Blood pressure is the pressure exerted by the blood on the walls of the blood vessels. The pressure of the blood in other vessels is lower than the arterial pressure. The peak pressure in the arteries during the cardiac cycle is the systolic pressure and the lower pressure (at the resting phase of the cardiac cycle) is the diastolic pressure. Typical values for the arterial blood pressure of a resting, healthy adult are approximately 120 mmHg systolic and 80 mmHg diastolic (written as 120/80 mmHg), with large individual variations.

Procedure for measurement of heart rate :

Heart rate is a good index of physical as well as physiological load on the operator. The heart rate was measured with the help of ordinary stethoscope. The tractor operators were allowed to relax for 10 min before commencement of operation. The heart rate reading was taken by positing the diaphragm of the stethoscope on the chest of the operator before and after commencement of operation and in this way the heart rate per minute was computed. The heart rate is affected by such parameter as environmental temperature and humidity, type of clothing, noise, dust and vibration levels, operator posture and mental stresses, steady O₂ consumption accompanied by increased heart rate also signifies muscular fatigue of subjects (Noble *et al.*, 1983). The basic parts of the stethoscope includes a chest piece, a rubber tube, head frame and ear knobs.

Procedure for measurement of noise :

Noise level is measured with tractor and tillage implements under different field condition and measurement were taken at driver's ear level. Digital sound level meter of SL 4001 (Lutron) was used having 3½ inch digit LCD display, 18 mm size, function dB (A and C weight) Fast, slow and maximum hold response. A weight measure sound level of 30-130 dB and C weight measure sound level of 35-130 dB range. For machinery noise measurement, put the sound level meter on C weight with slow response to give better and

accurate reading. The sound level meter having electrical condenser microphone with frequency 31.5 to 8000 Hz. When tractor was stopped, the level of the noise was measured as 50-63 dB under different field condition at driver's ear level. The noise level was measured during tractor tillage operation with implement rotavator. The noise levels were varying during tillage operation under different field condition due to the different force acting on the soil (Bansal *et al.*, 1982).

Sound pressure level (SPL) can be expressed as sound pressure level with respect to a reference pressure. It is usually measured in db.

$$SPL = 10 \log_{10} \left[\frac{P}{P_0} \right]^2$$

$$SPL = 20 \log_{20} \left[\frac{P}{P_0} \right]$$

where,

P = R.M.S. sound pressure (μbar)

P_0 = reference pressure (μbar)
= 0.0002 (μbar).

L_{eq} is the average sound pressure level during the measurement period time T, during that period, the real noise level fluctuated, and therefore, its acoustic energy varied. The measurement of average sound pressure level is based on the equal energy principal and given by the formula

$$L_{eq} = 10 \log_{10} \frac{1}{T} \int_0^T \left[\frac{P(t)}{P_0} \right]^2 dt \quad (\text{dB})$$

where,

P (t) = Time varying sound pressure (μbar)

P_0 = Reference sound pressure (μbar)
= 0.0002 (μbar)

T = Total measured time (sec).

RESULTS AND DISCUSSION

The results on various aspects of the work have been presented and interpreted. Inferences have been drawn from the results. The findings are discussed logically in the view of suitable reasons and possible support of literature.

Effect of physiological response on operator of 21-30 year of age group during tillage operation with new tractor on dry and wet field conditions:

Fig. 1 presents the data on various physiological responses of 21-30 year of age group during tillage operation with new tractor on dry fields before and after commencement of operation. The average body temperature of tractor operators worked with rotavator on dry field condition before commencement was 97.22 °F. Similarly the average systolic blood pressure was observed 113.66 mm Hg whereas the average diastolic blood pressure was 67.13 mmHg and the average heart beat rate was 72beats/min. After commencement of 3 h duration of work, significant changes were observed on physiological responses of tractor operators. The tractor operators worked with rotavator, the average body temperature, average systolic blood pressure, average diastolic blood pressure and average heart rate increased by 0.72%, 14.12%, 23.16% and 32.22%, respectively.

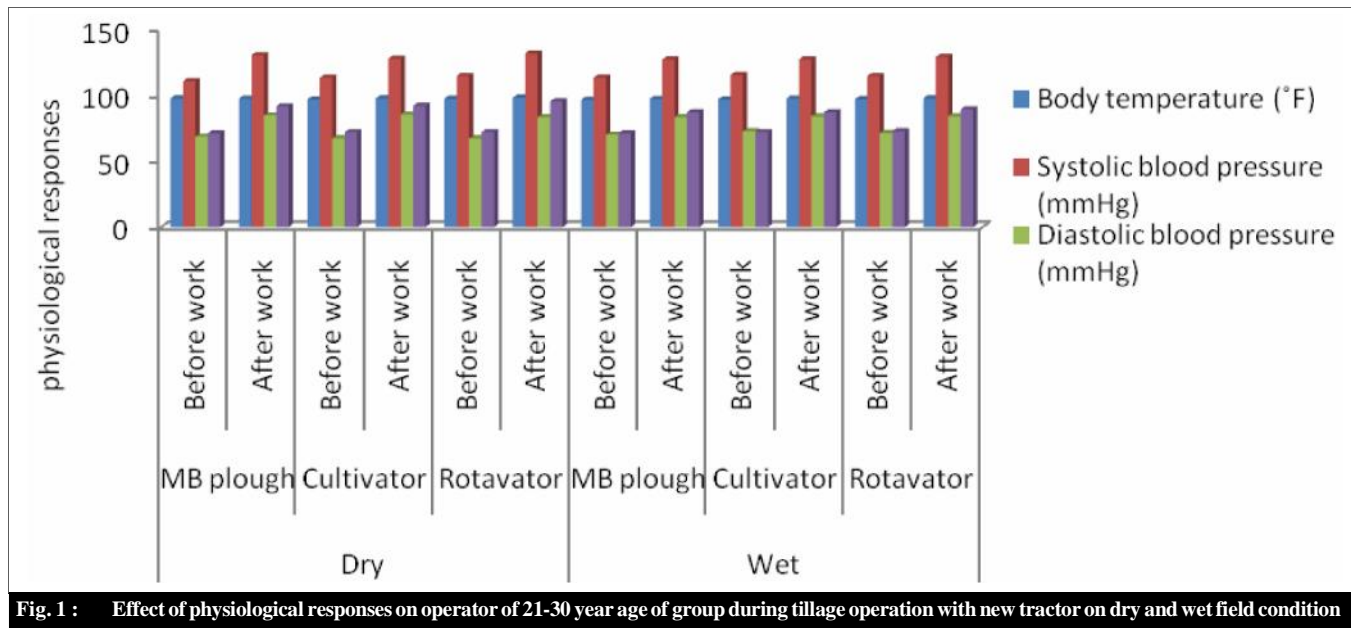


Fig. 1 : Effect of physiological responses on operator of 21-30 year age of group during tillage operation with new tractor on dry and wet field condition

Fig. 1 presents the data on various physiological responses of 21-30 year of age group during tillage operation with new tractor on wet fields before and after commencements of operation. The average body temperature of tractor operators worked with rotavator on wet field condition before commencements was 97.23 °F. Similarly the average systolic blood pressure was observed 113.66 mmHg whereas the average diastolic blood pressure was 71.13 mmHg and the average heart beat rate was 72.26 beats/min. After commencements of 3 h duration of work, significant changes were observed on physiological

responses of tractor operators. The tractor operators worked with rotavator, the average body temperature, average systolic blood pressure, average diastolic blood pressure and average heart rate increased by 0.59%, 12.40%, 17.76% and 22.45%, respectively.

Effect of physiological response on operator of 31-40 year of age group during tillage operation with new tractor on dry and wet field conditions :

Fig. 2 presents the data on various physiological responses of 31-40 year of age group during tillage operation

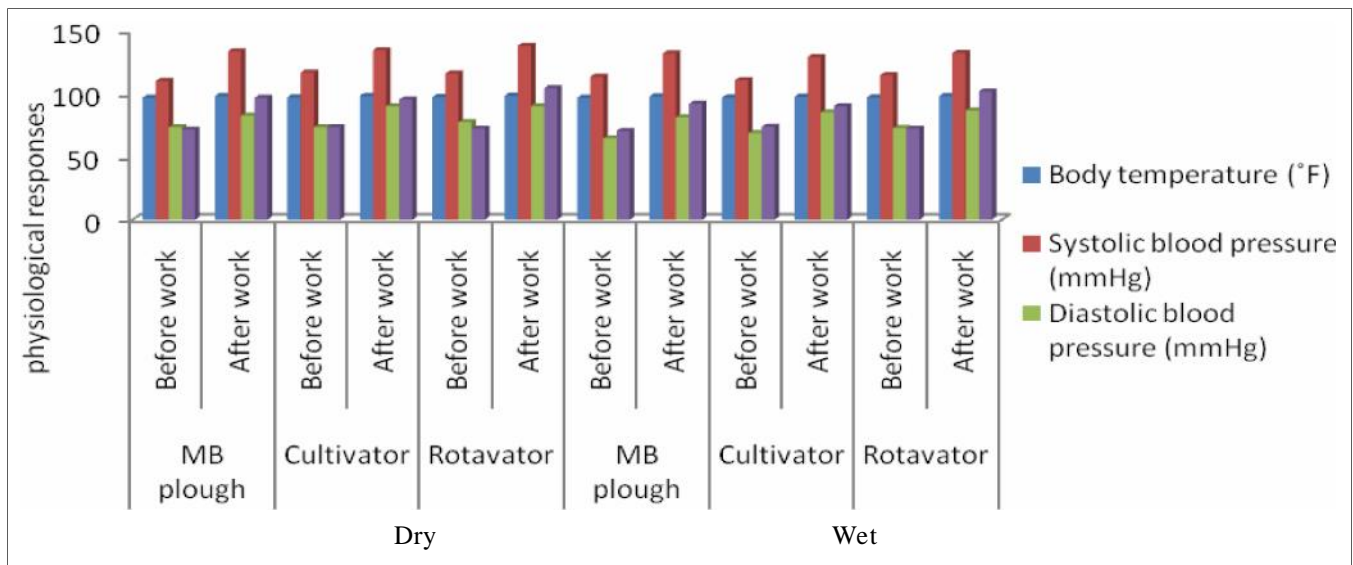


Fig. 2 : Effect of physiological responses on operator of 31-40 year of age group during tillage operation on dry and wet field condition

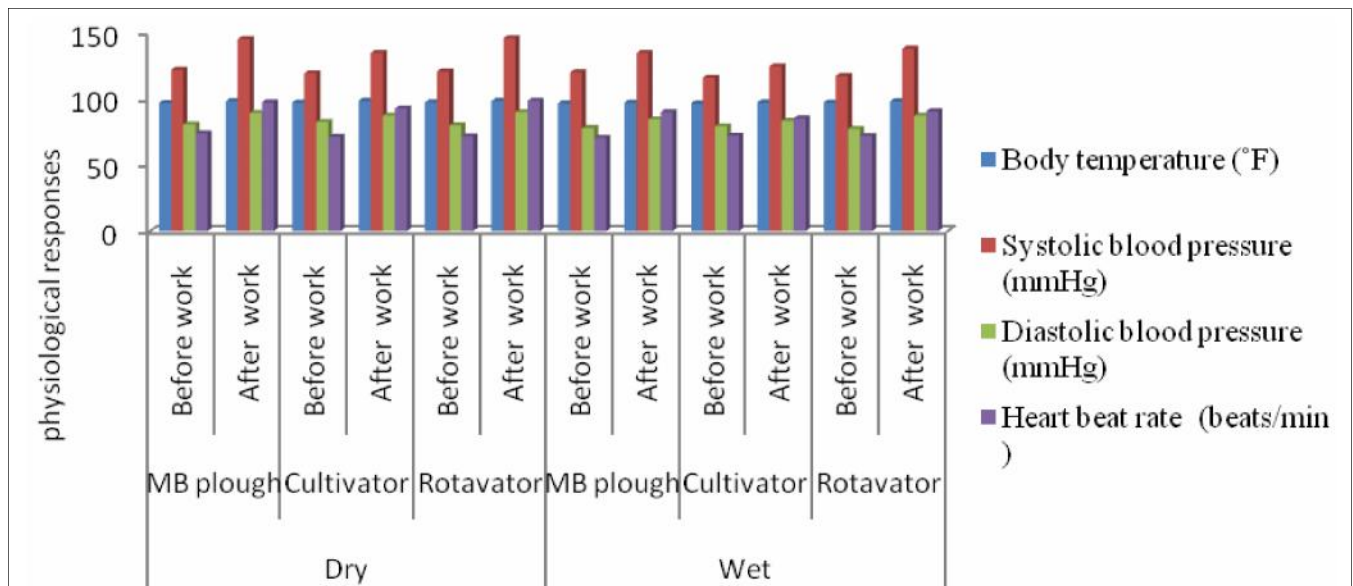


Fig. 3 : Effect of physiological responses on operator of 41-50 year of age group during tillage operation with new tractor on dry and wet field condition

with new tractor on dry fields before and after commencements of operation. The average body temperature of tractor operators worked with rotavator on dry field condition before commencements was 97.14 °F. Similarly the average systolic blood pressure was observed 120.16 mmHg whereas the average diastolic blood pressure was 80.0 mmHg and the average heart beat rate was 71.26 beats/min. After commencements of 3 h duration of work, significant changes were observed on physiological responses of tractor operators. The tractor operators worked with rotavator, the average body temperature, average systolic blood pressure, average diastolic blood pressure and average heart rate increased by 1.00%, 21.0%, 12.2% and 34.88%, respectively.

Effect of physiological response on operator of 41-50 year of age group during tillage operation with new tractor on dry and wet field conditions:

Fig. 3 presents the data on various physiological responses of 41-50 year of age group during tillage operation with new tractor on dry fields before and after commencements of operation. The average body temperature of tractor operators worked with rotavator on dry field condition before commencements was 97.16 °F. Similarly the average systolic blood pressure was observed 120.0 mmHg whereas the average diastolic blood pressure was 86.0 mmHg and the average heart beat rate was 74.0 beats/min. After commencements of 3 h duration of work, significant changes were observed on physiological responses of tractor operators. The tractor operators worked with rotavator, the average body temperature, average systolic blood pressure, average diastolic blood pressure and average heart rate increased by 1.44%, 30.0%, 11.12% and 48.64%, respectively.

Fig. 3 presents the data on various physiological responses of 41-50 year of age group during tillage operation with new tractor on wet fields before and after commencements of operation. The average body temperature of tractor operators worked with rotavator on wet field condition before commencements was 97.19 °F. Similarly the average systolic blood pressure was observed 119.14 mm Hg whereas the average diastolic blood pressure was 79.34 mmHg and the average heart beat rate was 74.26 beats/min. After commencements of 3 h duration of work, significant changes were observed on physiological responses of tractor operators. The tractor operators worked with rotavator, the average body temperature, average systolic blood pressure, average diastolic blood pressure and average heart rate increased by 1.09%, 26.27%, 19.10% and 32.24%,

respectively.

Conclusions:

- The maximum changes in physiological responses were found when tillage operation was performed by the rotavator under dry conditions.
- In wet field conditions the change in physiological responses and the effect of noise and vibration on tractor operator were minimum as compared to dry field conditions.
- Tillage operation done by the cultivator under wet conditions gave minimum effect on tractor operators.
- The maximum noise level was 100.26 to 108.34 dB during rotavator operations with old tractor on dry field conditions whereas, the minimum were 93.36 to 96.34 dB during cultivator operation with new tractor on wet field conditions.
- The minimum vibration level 1.03 to 0.84 m/sec² was found during cultivator operation with new tractor under wet conditions whereas; the maximum vibration level 2.76 to 3.43 m/sec² was found during rotavator operation with old tractor under dry field conditions.

Authors' affiliations:

GEETA, Shivdam Singh Institute of Technology and Management, ALIGARH (U.P.) INDIA

VISHAL KUMAR, Sardar Vallabhbhai Patel University of Agriculture and Technology, MEERUT (U.P.) INDIA

REFERENCES

- Bansal, A.S., Bachniwal, N.S. and Kumar, A. (1982).** Survey of noise levels of tractors. Paper presented at XIX ISAE Annual convention held at Udaipur on Feb. 15-17.
- De Waard, D., Jessurum, M., Steyvers, F.J., Raggatt, P.T. and Brookhuis, K.A. (1995).** Effect of layout and road environment on driving performance, driver's physiology and road appreciation. *Ergonomics*, **38** (7) : 1395-1407.
- Milosevic, S. (1997).** Driver fatigue studies. *Ergonomics*, **40** (3) : 381-390.
- Noble, B.J., Jacob, I. and Kaiser, P. (1983).** A category ratio perceived exertion scale: relation to blood and muscle lactates and heart rate. *Medicine & Sci. Sports & Exercise*, **15** (6) : 523-528.
- Saha, P.N., Data, S.R., Banerjee, P.K. and Narayane, G.G. (1979).** An acceptable workload for Indian worker. *Ergonomics*, **22** (9) : 1059-1071.
- Solecki, L. (1998).** Effects of occupational exposure to noise among tractor drivers: assessment based on noise emission level. *Medycyna Pracy*, **49**(6): 535-544.

6th
Year

★★★★★ of Excellence ★★★★★