

## **ABSTRACT**

Human labour is the most expensive resource in agricultural operations and plays a crucial role throughout the farming process. In Indian agriculture, large-scale use of manually operated equipment is done for various agricultural works, from seed sowing to post-harvest operations. Most of these tasks (push, pull, cranking, pedaling, and treadling) are completed with the help of agricultural machinery. For example, push-pull tasks are mainly used for weeders, manually operated rice transplanters/seeder, wheelbarrows, etc. Hand cranking is used for various applications, such as chaff cutting, fodder cutting, corn dehusking, corn shelling, etc. Pedaling is used in foot-operated threshers, maize shellers, pedal-powered pumps, etc. Treadling is mainly used in pedal-operated paddy threshers and for irrigation purposes. Since these are manually operated machinery, long working hours in awkward positions are expected, which causes physical stress and musculoskeletal disorders in the operators. Most agricultural equipment manufacturers are preoccupied with enhancing the equipment's efficiency and durability but pay little attention to the worker's comfort.

According to anthropometric parameters, two laboratory test setups were developed: one for push and pull and the other for cranking, pedaling, and treadling operations to measure and simulate the physiological workload at different loads. An electromyographical (EMG) approach was carried out to evaluate the most used muscles during selected operations at different loads. An ergonomic evaluation of the above operations was conducted to assess their suitability for the selected subjects. The evaluation was carried out in terms of physiological and psychophysical parameters like heart rate, oxygen consumption rate, energy expenditure rate, limit of continuous performance, acceptable work load, overall discomfort rate, and body part discomfort score.

The average energy expenditure rate (EER) for 50 to 200 N load for pushing operations ranges from 7.54 to 15.69 kJ/min and for pulling operations from 8.20 to 17.28 kJ/min. The average EER of the subjects with 10, 30, 50, and 70 N loads during cranking was 12.34, 14.60, 18.17, and 24.86 kJ/min, and the corresponding values for pedaling operations were 11.48, 14.54, 16.38, and 19.89 kJ/min, respectively. Muscle activity was increased with increasing load for each of the selected muscles in all the selected tasks. The root mean square values for EMG activity increased with increasing load in all the selected muscles, indicating that muscular loads were affected by the external load in all the selected tasks. The activity of the middle deltoid and triceps brachii muscles was more during the pushing than the pulling task. The most activated or used muscle during pushing was the triceps brachii; for pulling and cranking was the brachioradialis; and for pedaling and treadling operation was the gastrocnemius muscle. So, these muscles get more fatigue.

**Keywords:** Electromyography, Pushing, Pulling, Cranking, Pedaling, Treadling, Physiological cost, Working heart rate, Oxygen consumption rate, Energy expenditure rate, Overall discomfort rate, Load, Muscular activity, Maximum Voluntary Contraction.