

## **Comparison between conventional human energy measurement and physical human energy measurement methods in wetland rice production**

### **ABSTRACT**

Measurement of human energy expenditure during crop production helps in the optimization of production operations and costs by identifying steps which that can benefit from the use of appropriate mechanization technologies. This study measures human energy expenditure associated with all 6 major rice (*Oryza sativa* L.) cultivation operations using two measurement methods-i.e. conventional human energy expenditure method and direct measurement with a Garmin forerunner 35 body media. The aim of this study was to provide a detailed comparison of these two methods and document the human energy costs in a manner that will identify steps to be taken to help optimize agricultural practices. Results (mean + 95%CL) revealed that the total human energy expenditure obtained through the conventional method was 25.5% higher ( $33.3 \pm 1$  versus  $26.6 \pm 1.3$ ) in transplanting and 26.1% higher ( $30.3 \pm 1.9$  versus  $24.0 \pm 2.1$ ) than the human energy expenditure recorded using the Garmin method in broadcast seeding method. Similarly, during the harvesting operation, the conventional measurement and Garmin measurement methods differed significantly, with the conventional method the human energy expenditure was 89.9% higher ( $3.2 \pm 0.4$  versus  $1.68 \pm 0.2$ ) in the fields using the transplanting and 88.7% higher ( $3.3 \pm 0.5$  versus  $1.8 \pm 0.3$ ) in the fields using the broadcast seeding than the human energy expenditure recorded using the Garmin method. When using Garmin method, the human energy expenditure in the case of using the midsize combine harvester was 13.49% lesser ( $592.4 \pm 67.2$  versus  $522.0 \pm 75.1$ ) than the case of using conventional one. Results based on heart rate also indicated that operations such as tillage were less intensive ( $72 \pm 3.3$  bpm) compared with operations such as chemicals spraying ( $135 \pm 4$  bpm). Although we did not have a criterion measure available to determine which method was the most accurate, the Garmin measurement gives an estimate of actual physical human energy expended in performing a specific task with consider all conditions and thus more information to aid in identifying critical operations that could be optimized and mechanized.

**Keyword:** Agriculture; Energy; Agricultural engineering; Agricultural policy; Agricultural technology; Rice; Human energy; Conventional measurement; Garmin measurement; Heart rate