

ABSTRACT

An investigation has been carried out to design and develop an animal drawn rotary puddler for the north eastern region from mechanical and ergonomic considerations. Accordingly three animal drawn puddling implements namely a rotary puddler, a 3-tine tiller and a local plough are tested under controlled conditions in a soil bin. These are operated at a forward speed of 1.36 km/h when the plot is submerged with 3.0 cm of water. The depth of operation is 7.5 cm. During the operation, the soil reaction forces are recorded with specially designed octagonal ring transducers. After the different levels of passes with an implement puddling index and soil physical properties like hydraulic conductivity, shear strength, cone index and bulk density for puddled as well as non-puddled soil have been evaluated at intervals of 24 hours till 216 hours. The non-capillary pore space percentage are also evaluated for different implements at different level of passes. The same procedure is repeated for all the passes. From the data, specific energy is computed. Mathematical models have also been developed to predict the soil physical properties with respect to relative age of puddled and non-puddled soils. The study indicates that the rotary mode gives relatively higher puddling index than others but there is scope for further modification. Accordingly, experiments are carried out to optimize the size of blade and blade angle using response surface methodology. The experimental observations have been used to develop regression models to predict soil reaction forces, puddling index, specific energy and performance index for different blade parameters. The results suggest that rectangular blade of 15 cm x 8.5 cm size gives higher puddling index with a blade angle is 30°. Further improvement is achieved with 6 numbers of rectangular concave blades in a row.

For ergonomic studies three subjects, representing of 5th, 50th and 95th percentile of agricultural worker population are selected. They are used in a laboratory study to find out the effect of temperature, relative humidity, and imposed work load on Energy Expenditure Rate under controlled conditions in a psychrometric chamber. Based on the results, equations are developed to predict HR and OCR for varying levels of temperature, relative humidity and work load.

On the basis of the results of laboratory studies, a new rotary puddler has been developed. It is incorporated with four rows of blades arranged in a helical form. In each row six numbers of blades with optimised parameters are fitted. An ergonomically designed seat is provided to the unit. The results of the field tests reveal that the new rotary puddler is superior to others in terms of puddling index, performance index as well as EER. The operation of the puddler is scaled as moderately heavy.

KEY WORDS Puddling; Rotary Puddler; 3-Tine Tiller; Local Plough; Laboratory Evaluation; Draft; Puddling Index; Specific Energy; Number of Passes; Relative Age; Soil Physical Properties; Optimisation; Mathematical Models; Performance Index; Ergonomics; Energy Expenditure Rate; Vibration; Field Evaluation; Improved Rotary Puddler.