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Wetland traction research: Present status and future need

ARVIND KUMAR AND D.C. BARUAH

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See end of the Paper for authors' affiliation

Correspondence to:

ARVIND KUMAR
Division of Agricultural Engineering, ICAR Research Complex for NEH Region, BARAPANI (MEGHALAYA) INDIA
Email:arvindkr30@yahoo.com

ABSTRACT : Wetland traction is special area in the broader field of farm mechanization research. The requirement of mechanized cultivation, especially for paddy crops has increased its importance. Trafficability of the surface soil layer of paddy field is very poor, being extremely soft with low load bearing capacity. Farm tractors and power tillers operated in these conditions require special traction devices such as cage wheel for better trafficability. A number of research works have been reported on wetland traction. These could be broadly divided into specific areas such as (a) performance analysis of cage wheels operated in wetland, (b) behaviour of soil under the action of traction device (c) new design of wetland traction device; (d) traction dynamics study and (e) optimization of design parameters. Circumferential lugs provided in the cage wheel assists traction. However, optimal design of lugs with reference to its geometry and spacing has been a major area of investigation. Deteriorating performance of cage wheel resulted by excessive sticking of wet clay has been reported through experimental investigations. Three distinct mechanisms arising from improper combination of lug spacing and wheel slip have been identified as the primary causes of excessive adherence of clay soil to metal cage wheel.Coating of the metal cage wheel using non-sticky material like enamel, to improve cage wheel performance has also been attempted with positive results at varying degree of wheel slip up to 100 per cent. The performance of cage wheel mounted with tractor was also been assessed under varying operating and design conditions. At a constant hardpan of 30 to 40 cm the increase in traction up to 59 per cent was reported due to increase in wheel diameter by 7per cent. The inflation pressure of driving tyre and forward speed did not affect the traction performance in this test. Substantial enhancement in wetland traction (up to 48% increase in draw bar pull) of power tiller by using specially designed extension strake as traction aids was reported by experimental investigation in soil bin. Enhancement of net traction of two wheel drive tractor in soft clay soil was reported with the increase in axle load. Results of the same investigation also indicated non-significant effect of tyre inflation pressure on drawbar power except at the highest ballasting of 2.2 kN on the drive axle. Further, deteriorating traction performance was reported with increase in soil moisture content due to flooding. Some studies were also dedicated to make experimental investigation of soil reaction forces on lug with varying degree of analytical support. Such studies provided useful information for designing traction aids, especially lugs of cage wheel. However, in majority of the cases optimal design parameters of traction aids are decided based either (i) on the experimental results concerning some fixed set of system parameters or (ii) optimal values obtained from statistically analyzed results of experiments. This necessitates further research work aiming to develop effective analytical tool for wetland traction.

KEY WORDS : Cage wheel, Traction performance, Lug spacing, Wheel slip, Sinkage

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The traction power developed by the tractor or power tiller is the result of interaction of traction device and soil surface. In wet conditions the stability of the aggregate is reduced, the soil becomes soft and unable to support the applied load. In these conditions wheel slip and sinkage is increased and tractive efficiency is decreased. Farm tractors and power tillers operated in these conditions require special traction aids and devices such as cage wheels for better traction. The cage wheel has been proved to be the most effective traction aid. Experiments have revealed up to three times more pull exerted by cage wheels in comparison with inflated tyres in flooded soil conditions.

Attempts have been made to optimize different parameters of cage wheel such as lug spacing, lug angle and lug dimensions (Fig A). Providing additional circumferential rings, opposing circumferential lugs and coating of the metal