ABSTRACT

Feeding with precision plays a vital role in aquaculture to reduce feed wastage, and is crucial for sustainable growth of aquaculture. Various kinds of feeding devices are available in market, yet the small and marginal fish farmers of developing countries still depend on the cheaper conventional feeding methods. The present investigation was carried out with the aim of mechanizing the feeding operation cost effectively. A simple efficient feeding system mounted on a human – powered catamaran (HP – CAT), which can feed large ponds independently was designed and developed. A preliminary investigation was conducted with a fish feeder design consisting of two feed drums mounted on a feed shaft. The feeding unit was attached to a frame and the frame was mounted on two floats that enable the entire system to stay afloat in pond. A paddle-wheel propeller was used for propulsion and a rudder was attached to the extended steering shaft which can turn the fish feeder in water. A seating arrangement was provided for the operator. When the operator pedals, the power was transmitted from the pedal to the feed shaft and propeller shaft via chain and sprocket drive. The feeder was designed to use pedal power for operating the feeding unit as well as for propelling the fish feeder. The pilot study experimental results called for a better metering mechanism which can improve feed control and a customized catamaran for this application. Streamlining the hulls were deemed necessary to reduce drag and make the operation less strenuous for the operator. Based on the pilot study findings, a HP – CAT fish feeder prototype with fluted – roller metering mechanism was developed. A Wigley hull with optimum dimensions L = 1.7 m, b = 0.45 m, T = 0.2 m and freeboard = 0.125 m, was designed for the catamaran. The $\overline{GM_T}$ and $\overline{KG}$ for the catamaran were computed from the inclining experiment and found to be 2.034 m and 0.675 m respectively, which indicated good stability. The optimum stability conditions and the full layout of components on – board for the HP – CAT fish feeder have been studied and reported. The feeding unit operating parameters were optimized in laboratory and the optimum settings which achieved the desired feed rate of 72 kg/ha was found to be at a chute exposure length of 2.9 cm, shaft speed of 30 rpm and hopper fill level of 100 %. The field performance of the HP – CAT fish feeder and ergonomic assessment were carried out at three pedal cadences 15 rpm, 20 rpm and 25 rpm. The pedal cadence recommended for operation was 15 rpm which corresponds to a forward speed of 1.8 km/h. The actual field capacity and field efficiency achieved at this pedal cadence were 0.30 ha/h and 93 % respectively. The mechanical power requirement for operating the fish feeder at 15 rpm under moored condition was found to be 46.87 ± 0.57 W. The power requirement is lower than the maximum power recommended for intermittent operation (i.e. 200 W). The corresponding average force applied on the pedal by operator feet was 180.8 N. The energy expenditure rates of both male and female subjects indicated that operation at 15 rpm can be categorized as “light” work. Feeding with HP – CAT fish feeder is estimated to cut down the feeding cost by 49 – 66 % compared to manual feeding. The HP – CAT

fish feeder proved economical and can improve the precision, timeliness of feeding operation and reduce human drudgery involved in manual feeding. Further, a systematic series design approach was conducted and a family of catamaran design for low – draft applications in aquaculture have been proposed.

Keywords: Fish feeder; Human-powered catamaran; Inclining experiment; Performance evaluation; Ergonomic assessment; Cost analysis.