Title: Design and Development of a Self-Propelled Chili Pepper Harvester
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ABSTRACT

Chili (Capsicum annuum L.) is an important spice cum vegetable crop cultivated throughout the world. In India, chilies are cultivated over an area of 0.68 M ha, yielding an annual production of 1.7 Mt with an average productivity of 2.23 t/ha. However, Chili peppers have been traditionally harvested by hand, which required 40-50 labours per ha which turns to 50% of the total cost of production. Therefore, chili harvesting needs to be mechanized to meet the high demand for efficient and timely harvesting. In light of these considerations, this study was aimed at designing and developing a self-propelled chili pepper harvester for small and marginal farmers.

Firstly, a laboratory setup was developed comprising a plant conveying system, chili pepper picking mechanism, real-time operation system, and power transmission system. The plant conveying system was able to hold the crop plants vertically and convey them to the picking mechanism at the desired speed. The comb-type picking mechanism was selected based on the physical and mechanical properties of chili peppers and chili plants. The picking mechanism features two drums or rotating links that move in opposite directions, parallel to each other. Each drum carries combs on its periphery, with the combs arranged parallel to one another and perpendicular to the drum's axis. The drums are positioned so that their combs strike the chili pods simultaneously, applying an impact force that detaches the pods from the plants. The performance of the picking mechanism was analysed with an analysis of variance and central composite design. The maximum peak power of 66.98 W was recorded at rotational speeds of 200 rpm. The maximum picking efficiency at laboratory conditions was found to be 84.67 % at a plant conveying speed of 0.80 rpm and rotational speed of 200 rpm with 1.2 % chili pepper damage rate. The optimized value for the plant conveying speed was 1.47 km/h and the rotational speed of the picking unit was 177.55 rpm, which results in maximum picking efficiency of 78.17 %, minimum chili pepper damage of 2.62 %, and minimum unpicking efficiency of 21.22 % with a desirability value of 0.616.

A prototype of self-propelled chili pepper harvester consists of the main frame, guiding unit, picking mechanism, conveying unit, collecting unit, and hydraulic transmission system. A diesel engine with a rated power of 4 hp and a speed of 2600 rpm was used as the prime mover. The frame was attached to the prime mover for harvesting and detached afterward, allowing the prime mover to be used for other agricultural tasks. The maximum picking efficiency was found to be 78.51 % at a speed of operation of 0.80 km/h and a rotational speed of 200 rpm. The minimum damage rate was found to be 1.96 % at a speed of operation of 1.65 km/h and a rotational speed of 140 rpm. The analysis results show that the picking efficiency and chili pepper damage rate were affected significantly by the speed of operation and picking unit rotational speed. The maximum peak power consumption of 111.50 W were recorded at rotational speeds of 200 rpm. The fuel consumption was 0.87 l/h with an actual field capacity and field efficiency of 0.042 ha/h and 65.62 % at a forward speed of 0.80 km/h. Harvesting of chili pepper using the developed harvester saves 36% cost and 88.87 % time with respect to the traditional harvesting method. The performance of the developed harvester was found to be satisfactory and could be used effectively by small and marginal land-holding farmers.

Keywords: Comb type picking mechanism, chili pepper harvester, picking efficiency, damage rate