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Research Paper :

Force and energy required for cutting pigeonpea stems

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ABSTRACT

An attempt was made to investigate the cutting energy and force required for the pigeonpea stem at maturity of crops. The moisture content in the stem at the time of harvesting was 41.20% (w.b.). A blade, sharpened at 30^0bevel angle was attached to the lower end of the arm, which cut the stalk at 90^0 to the stalk axis with knife velocity ranging between 2.4 m/s to 6.6 m/s. The cutting energy and maximum cutting force were directly proportional to cross-sectional area of pigeonpea stem. The maximum energy and force observed to cut the stem of 30mm diameter were 141.90 Nm and 747.25 N, respectively.

Key words : Cutting energy, Force, Pendulum type dynamic tester, Velocity, moisture

The principle of operation of the cutting element employed in any harvesting tool or equipment can be broadly classified under two categories *viz*., (i) cutting by impact and (ii) cutting by a counter-edge.

Two types of cutting mechanism, reciprocating type and rotary impact type, used for harvesting *viz.,* sorghum harvesting, forage harvesting, weeding, lawn mowing, etc. The latter is being increasingly used in these operations due to its simplicity in construction, low maintenance cost and ability to but both small and large diameter stalks. Effectiveness of impact cutting system as a viable alternative to the counter edge cutting is being progressively explored.

Cutting using single element differs greatly from that using two opposed elements. The latter case is cutting with counter-edge and thus, the stalk is supported in the vicinity of the cutting element. In this case, there is little or no energy wasted in the stalk deflection before cutting. Cutting with single element can be referred to as pure impact cutting and depends mainly on the knife speed, cutting edge sharpness and crop inertia. Stalk resistance to bending is insufficient by itself to provide the force necessary to oppose the knife pressure required to penetrate the material; the cutting process depends on the stalk inertia to give the required opposing force (Prasad and Gupta, 1975).

The energy required for the cutting unit of stalk cutter may be categorized as: friction in the moving parts of the machine and air friction; kinetic energy required to accelerate the chopped material; energy required to overcome friction of the chopped material against the stationary parts of machine; and energy required to cut the stalk (O'Dogherty *et al.,* 1995; Chattopadhyay and Pandey, 1999).

Despite the extensive studies conducted on properties of plants, stems and blade characteristics in relation to cutting performance (cutting energy) none was able to provide such comprehensive relationship for thick-stemmed crops as sorghum, millet, maize and pigeonpea.

Therefore, an attempt was made to investigate the cutting force and energy require for pigeonpea stems when they were subjected to impact cutting by pendulum type dynamic tester.

METHODOLOGY

A pendulum type dynamic tester was fabricated in the Department of Farm Power and Machinery, Dr. PDKV, Akola (M.S.). The dynamic tester is given in Fig.1. The line sketch (Fig. 2) shows the different forces acting on the blade edge and pivot point.

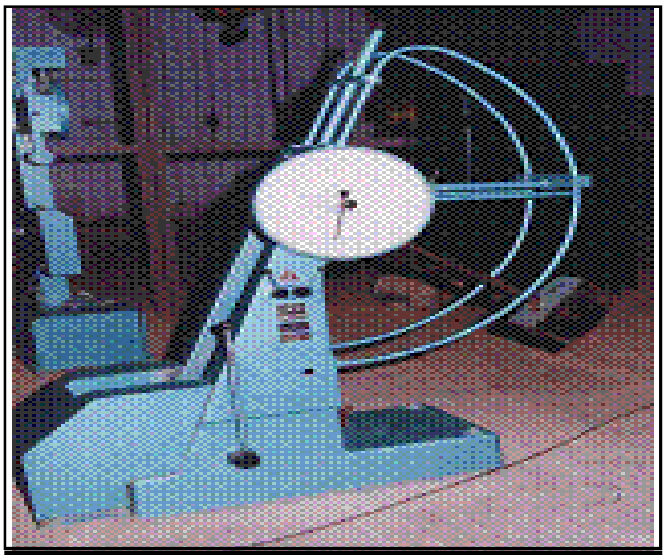

Fig. 1 : Pendulum type dynamic tester