DEBARKING MACHINE FOR JIGAT TREE

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SUMMARY AND CONCLUSION

CHAPTER V

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Jigat bark is an important forest resource, and its efficient removal is essential for improving productivity while reducing manual labor. This study focused on the design, development, and evaluation of a portable debarking machine for Jigat (*Litsea deccanensis*) trees, along with an analysis of the influence of blade parameters and operating conditions on machine performance. The prototype was developed at Kelappaji College of Agricultural Engineering and Food Technology, Tavanur and the performance evaluation was conducted at the Kerala Forest Research Institute, Thrissur. The machine was operated in such a way that the cambium layer was not damaged, thereby ensuring the regenerative ability of the tree was fully preserved.

Initially, an experimental setup was developed to determine the piercing force required for bark penetration under different blade thicknesses of 1 mm, 2 mm, and 3 mm and rake angles of 30°, 40°, 50°, and 90°. The results showed that a 1 mm blade at 40° rake angle required lower piercing force and provided better penetration compared to other combinations. However, considering durability and field applicability, blade thicknesses of 2 mm and 3 mm were selected for further performance evaluation.

The machine was designed as a lightweight, ergonomically operated, battery-powered portable unit suitable for field conditions. It was fabricated using locally available materials, ensuring low cost, easy maintenance, and operational convenience for small and medium-scale field applications. The system was developed as a backpack-type unit, enabling easy carrying and operation by a single user in field conditions.

The machine performance was evaluated by varying blade shape, blade thickness, cutting speed, and rake angle. The blade shapes considered were single bevel edge, double bevel edge, and serrated blade. The cutting speeds were 500 rpm and 600 rpm, while rake angles of 40° and 50° were used. The performance was assessed in terms of material removal rate and specific power index.

The material removal rate ranged from 0.4 to 5.3 g s^{-1}, while the specific power index varied between 0.13 and 0.25 A g^{-1}, indicating variations in productivity and energy consumption under different operating conditions.

Among the blade shapes studied, the single bevel edge blade exhibited superior performance, achieving the highest material removal rate of 2.65 g s^{-1} and the lowest specific power index of 0.132 A g^{-1}. The double-bevel-edge blade showed moderate performance, whereas the serrated blade recorded the lowest material removal rate of 0.80 g s^{-1}.

Blade speed had a positive influence on performance. Increasing the speed from 500 rpm to 600 rpm improved the material removal rate from 1.46 to 1.69 g s^{-1}. Blade thickness had a relatively smaller effect, where increasing thickness from 2 mm to 3 mm increased the material removal rate from 1.52 to 1.63 g s^{-1}, but also increased current consumption from 3.2 A to 3.6 A.

The rake angle significantly affected performance, where the material removal rate decreased from 2.42 g s^{-1} at 40° to 0.73 g s^{-1} at 50°, indicating a reduction of approximately 70 percent. A rake angle of 40° provided better penetration, efficient engagement, and improved performance.

The best operating condition was observed with a single bevel edge blade of 2 mm thickness at 600 rpm and a 40° rake angle. Under these conditions, the material removal rate was 4.82 g s^{-1} with a current consumption of 2.87 A and a power requirement of 51.6 W. The bark removed had an average width of 34.5 mm, length of 20.5 cm, and weight of 32.3 g, with a processing time of 6.7 seconds. The peeling efficiency was 90 percent, and the mechanical advantage was 1.57.

The developed prototype is a compact, lightweight, and portable system having a total weight of 6.1 kg, making it suitable for field applications. It operates efficiently with low power consumption and is easy to handle by a single operator, thereby reducing human effort and improving operational speed during debarking operations.

Economic analysis showed that the total cost of fabrication was Rs. 17,716. The operating cost was Rs. 108.2 per hour, and the cost of operation was Rs. 6.23 per kg. The break-even point was 1334 kg per year, with a payback period of 4.85 months. The benefit cost ratio of 5.82 confirmed good economic feasibility. Additionally, bark properties such as average moisture content of 58.4 percent and hardness of 490 N were found to influence the debarking performance.

According to Ramana and Raju, a worker engaged in manual debarking can process approximately 1.875 kg of bark per hour, resulted in an income of Rs. 65.63 per hour at a rate of Rs. 35 per kg. In contrast, with mechanization, an operator can process up to 18 kg per hour, yielding an income of Rs. 607 per hour. Hence, the use of this machine considerably enhances the hourly earning potential compared to the manual method.

Overall, the developed portable debarking machine demonstrated improved productivity and a favorable specific power index, along with strong economic viability. Therefore, it can be effectively used for Jigat tree debarking, reducing manual effort and improving operational efficiency under field conditions.