DESIGN AND DEVELOPMENT OF A FOUR WHEELED HYDROSTATIC DRIVE OIL PALM FRUIT BUNCH COLLECTION-TRANSPORTATION MACHINE

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Introduction

Acute labour shortages and escalating labour costs have prompted many investigations towards adoption of total mechanisation in the oil palm plantation industry in Malaysia. Among the identified field operations that need to be mechanised include the cutting of fruit bunches and fronds, infield collection-transportation of fruit bunches and loose fruits, and loading-transportation of the collected fruit bunches to the mill. This study was initiated with special focus on mechanising the infield collecting-transporting operations in view of the urgency to introduce total mechanisation in the oil palm plantation industry in Malaysia. The main objective of the study was to design, develop and test a fully mechanised and integrated machine for infield collection and transportation of oil palm fresh fruit bunches in the plantation. The developed machine system would hopefully able to reduce the total dependence of labour, improve collection-transportation productivity, and last but not least will make agriculture as an attractive profession in Malaysia.

Materials and Methods

The machine overall construction consisted of the main chassis and driving unit, collection assembly, scissors lift type fruit bin, and associated hydraulic control unit. Its overall dimension was 4750 mm length, 1780 mm width, and 2080 mm height. The fruit bin was designed with maximum payload capacity of 1.5 metric ton. The bin had a single stage scissors lift with 2750 mm raise height. The machine had an hydrostatic four wheel drive and front wheel steering. It was powered by a 4 inline cylinders, naturally aspirated, direct injection V22003 Kubota diesel engine that was coupled to a TA1919 Vickers main pump. The engine had a rated power of 34.3 kW @ 2800 rpm and a net continuous of 29.8 kW. The engine ran on a fuel tank of 70 liter capacity while the pump operated on an oil tank size of 130 liter capacity. An hydraulic M48 Parkers hydraulic motor was used together with a 1:1 chain type gearbox and a 1:4.67 reduction differential gear to provide the turning torque to the front and rear wheel axles. The front and rear wheel axles were equipped with single and dual 7.5-16, 6 ply high lugged tyres, respectively.

AutoCAD R13 software package was employed to develop the scaled 3D conceptual model of the proposed machine system. Computations were made for determining the machine's total power requirements in accordance to the local terrain conditions.

Results and Discussion

Machine traction on undulating terrain was better with the combination of having an oscillating front axles and dual rear tyres. Machine manoeuvrability in the plantation fields was easier with the power assisted steering controls. Various functional components within the machine were hydraulically operated through a solenoid control system. All wheel axle hubs on the machine system have hydraulic actuating drum brake systems. The operation of the machine system was limited within the machine path, palm circles and the roadside. The operator steered the machine system forwards to the location of the laid fruit bunch. Upon reaching the fruit bunch, he operated the joy stick control to lower the collection assembly while steering the machine slightly for the fruit bunch to be inside the capture area of the clamping jaws. He activated the push button switch, which had been earlier set at automatic mode for the subsequent operational steps that involved clamping, lifting and releasing of the fruit bunch into the fruit bin to be completed. He steered the machine to collect all available cut fruit bunches within the field plot. Upon completion of the collection trip, he drove the machine to the roadside closed to the waiting main line transporter. He operated the respective levers to raise and unload the fruit bin contents into the main line transporter. He lowered the fruit bin to rest position before driving the machine back to the field plot for next collection trip.

Conclusions

A new machine system has been designed and developed for infield collection-transportation of fruit bunches for the oil palm plantation industry. This proposed four wheeled hydrostatic drive integrated machine system is capable of collecting-transporting the fruit bunches in the field and transporting-unloading the collected fruit bunches directly into the main line transporter at the roadside. The overall construction of the machine consists of the main chassis and driving unit, collection assembly, scissors lift type fruit bin, and associated hydraulic control unit. The operator drives and manoeuvres the machine along the plantation machine path and around palm circles, evacuates all available fruit bunches under the palm, transports and unload the collected fruit bunches for the collection trip directly into the main line transporter at the roadside. Extensive field evaluation and testing on the machine have yet to be conducted before it can be recommended to the oil palm plantations.

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