Mechanised Oil Palm Fresh Fruit Bunch Infield Collection-Transportation System

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Introduction

Manual picking and loading of fresh fruit bunches are labour intensive and arduous. For example, a loader working in the Mini Tractor-trailer system has to handle manually a total of about 400 to 600 fresh fruit bunches on a normal working day. The characteristics of the fruit bunches adds to the difficulties for manual handling. The fresh fruit bunches, besides having thorny finger-like surfaces, are big and heavy. The nature of work and monetary reward for such job specifications are not attractive to the younger workforce.

Presently, the only successful implemented fully mechanised system for infield collection-transportation of fresh fruit bunches in the plantation is the Mini Tractor-trailer with Grabber. The grabber unit is a two-section crane with a three-webbed finger-gripper that could reach 3.5 meters distance and lift at once a maximum of 3 small fresh fruit bunches. However, the machine configuration and picking method in the Mini Tractor-trailer with Grabber has some drawbacks. Firstly, being a two units machine system, its field manoeuvrability is quite limited. Second, operator has to follow several sequential steps to complete the task of picking and loading the fresh fruit bunches while driving the tractor. Thirdly, there are numerous head and body movements made by the operator during picking of the fresh fruit bunches randomly from the ground and loading of the picked fresh fruit bunches into the trailers. Such intensified movements cause fatigue and finally affect the operator's work performance. This study was conducted in view of the urgent need to reduce labour dependence and improve efficiency through mechanisation in the oil palm plantation in Malaysia, particularly, in the infield collection and transportation of the fresh fruit bunches. The general objective was to introduce a new machine system that adopts a completely mechanised, fully integrated, self-contained, and front picking concept for the infield collection-transportation of fresh fruit bunches in the oil palm plantation.

Materials and Methods

A prototype FFB Collector-transporter was designed, developed, modified and tested at the Department of Biological and Agricultural Engineering, Universiti Putra Malaysia. This four-wheeled, hydrostatic drive, integrated machine was designed for collecting-transporting the fresh fruit bunches in the field and unloading them directly into mainline transporter or trucks at the roadside. The overall construction of the machine consisted of the main chassis and driving unit, collection assembly, operator cab, scissors lift-type fruit bin, and associated hydraulic control unit. Various functional components of the machine were hydraulically operated through a solenoid control system. A computer drafting software package was employed to develop the 3D model of the prototype machine. Computations were made to determine the machine total engine power and total hydraulic pressure requirements in accordance to the local terrain conditions. Both laboratory and field trials were conducted on the FFB Collector-transporter machine. The measured parameters in the tests include total time of collection per trip (min), machine capacity (ton/h), labour output (ton/man-h), field capacity (ha/h), expected machine output (ton/day), loose fruit losses (kg/ha), and fuel consumption (L/kW-h). The laboratory trials were conducted firstly to check on the functionality of the machine functional parts and secondly to compare the performance between the FFB Collector-transporter and the Mini Tractor-trailer with Grabber. Based on the on this laboratory test, we were also able to know the maximum achievable expected output of the two machines operating under idea terrain conditions. The field trials were conducted to determine the performance of the FFB Collector-transporter on the actual terrain conditions for in an Oil Palm Plantation Malaysia. The study indicated the maximum achievable expected output of the machines operating under the actual terrain conditions. Finally, an economic cost analysis was made to compare the modified FFB Collector-transporter and the Mini Tractor-trailer with Grabber. The calculated parameters in the analysis were the total cost of infield collection-transportation (RM/hr and RM/ton) for both machine systems.

Results and Discussion

Performance comparisons of the FFB Collector-transporter against Mini Tractor-trailer with Grabber, in the laboratory under controlled and ideal condition having crop density of 1.48 ton/ha showed that picking and travelling times constitute the largest time percentage over other parameters, which include turning, transporting and dumping times. The travelling time for the FFB Collector-transporter is 46.91% of the total collection time per trip, whereas the picking time is 30.46%. The collection time, loose fruit loss, and fuel consumption of the FFB Collector-transporter are 36.3%, 130.9% and 16.1% less than that of the Mini Tractor-trailer with Grabber. Mean machine outputs for the FFB Collector-transporter is 35.5% greater than the Mini Tractor-trailer with Grabber. The ultimate machine outputs for the two are 60.01 ton/day and 38.71 ton/day, respectively.

Performance of the FFB Collector-transporter in a wet field condition having crop yield in the range from 0.44 to 1.37 ton/ha is showed that the total collection time per trip for the FFB Collector-transporter is in the

range from 7.5 to 16.7 minutes; depending on the crop yields. Machine capacity of the FFB Collector-transporter is in the range from 2.3 to 4.2 ton/h; depending on the crop yields. Labour output of the FFB Collector-transporter is in the range from 2.3 to 4.2 ton/man-h; depending on the crop yields. The FFB Collector-transporter shows field capacity, machine output, loose fruit loss, and fuel consumption in the range from 2.34 to 5.2 ha/h, 18 to 34 ton/day, 0.03 to 0.14 kg/ha, and 0.06 to 0.38 L/kW-h, respectively.

Economic comparisons of the FFB Collector-transporter with machine output of 34 ton/day against the Mini Tractor-trailer with Grabber with machine output of 24 ton/day showed that labour cost gives the highest percentage cost with values of 26.7% and 33.5% for the FFB Collector-transporter and the Mini Tractor-trailer with Grabber, respectively. Insurance, shelter and taxes cost shows the lowest percentage cost values of 5.3% and 4.8% respectively. Total cost for infield collection-transportation of fresh fruit bunches per hour basis for the FFB Collector-transporter is *RM*19.15. Total cost per hour for the modified FFB Collector-transporter is 20.4% higher than the Mini Tractor-trailer with Grabber. Total cost for the infield collection-transportation cost of fresh fruit bunches per ton basis with the FFB Collector-transporter is *RM* 4.51. Total cost per ton for the modified FFB Collector-transporter is 15% higher than the Mini Tractor-trailer with Grabber. A cost saving of *RM* 0.68 for every metric ton of fresh fruit bunches could be obtained with the FFB Collector-transporter over the Mini Tractor-trailer with Grabber.

System evaluation in the harvesting and handling of fresh fruit bunch for a plantation area of 800 ha made by 10 cutters for cutting the fresh fruit bunches, 3 units of machine system for infield collection-transportation of the fresh fruit bunches, 8 units of trucks for mainline transportation of the fresh fruit bunches, a weighing station at the field for recording the weigh of the transported fresh fruit bunches, and a weighing and unloading station at the mill indicated that the mainline transportation was the most time consuming task. The idle time and cycle time percentages for all tasks with the exception of infield collection-transportation task were lower for the system having the FFB Collector-transporter than the system having the Mini Tractor-trailer with Grabber. System cycle for the system having the FFB Collector-transporter is 23% lower than the system having the Mini Tractor-trailer with Grabber. Total idle time for the system having the FFB Collector-transporter is 36% lower than the system having the Mini Tractor-trailer with Grabber. System capacity for the system having the FFB Collector-transporter is 17.4% higher than the system having the Mini Tractor-trailer with Grabber. Labour efficiency for the system having the FFB Collector-transporter was 16.7% higher than the system having the Mini Tractor-trailer with Grabber.

Conclusions

A mechanised system has been successfully designed, developed and tested at the Department of Biological and Agricultural Engineering, Universiti Putra Malaysia for infield collection and transportation of oil palm fresh fruit bunches. Field evaluation test on the prototype machine resulted in a projected machine output of 34 ton/day or machine capacity of 4.2 ton/h at a cost of RM4.51/ton. Collection and transportation cost reduction per ton of 16.6 percent or a cost saving of RM0.68 for a ton of fresh fruit bunches was obtained with the machine over the Mini Tractor-trailer with Grabber. Amount of dislodged fruits due to the action of the picker mechanism during the picking task is less than 0.55kg/ha; a reduction of about 130.9% from that of the Mini Tractor-trailer with Grabber.

Benefits from the study

The developed prototype machine has great potentials for positive contributions towards high labour output and better cost economy in mechanising the infield collection and transportation of oil palm fresh fruit bunches.

Literature cited in the text

None.

Project Publications in Refereed Journals

Ali, M and A Yahya. 2000. Design and development of a four-wheeled hydrostatic drive oil palm fresh fruit bunch collection-transportation machine. The Planter, Kuala Lumpur, 76(889): 225-240.

Ali, M and A. Yahya. 2001. Comparison Performance of Infield Collection-transporter and Mini Tractor-trailer with Grabber. (Accepted to be published in the The Planter, Kuala Lumpur.).

Project Publications in Conference Proceedings

Ali, M and A Yahya. 2001. Mechanised system for infield collection-transportation of oil palm fresh fruit bunches. In: Proceedings of National Conference on Agricultural and Food Mechanisation 2001: Enhancing transformation through mechanisation, Kuala Lumpur, 30-31 October 2001.

Ali, M and A Yahya. CAD conceptual design of a four-wheeled oil palm fruit bunch collector-transporter. In: Proccedings of World Engineering Congress and Exhibition, Kuala Lumpur, July 19-22, 1999.

Ali, M and A Yahya. Design concept of a four-wheeled hydrostatic drive oil palm fruit bunch collection sysyem. In: Proccedings of National Conference on Engineering SMART farming for the Next Millennium, UPM, Serdang, March 14-16, 1999.

Graduate Research

Mutasim El Tayeb Ali. 2002. Bio-Production Machinery Engineering. [PhD]. Universiti Putra Malaysia.

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