HYDRA-PORTER: HYDRAULICALLY POWERED 4-WHEEL FFB TRANSPORTER FOR SOFT STRUCTURED SOIL AND STEEP TERRAIN

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The use of tractor trailer either for in-field collection or mainline transportation of fresh fruit bunches (FFB) is a common practice in oil palm plantation (Rahim *et al.*, 1998). However, there are many cases whereby the FFB is unable to reach the collection point or mill due to the transporter being bogged down, especially on soft soil areas (Shamsudin, 2002). This poor traction is partly due to the conventional differential type of axle which has been fitted to the transporter. Therefore, a new transporter with four hydraulically powered individual wheels has been developed to improve tractive ability by eliminating the conventional axle.

The different thing about this new 4-wheel drive in-field transporter is that it is fully driven by hydraulic power, meaning all of the four wheels are driven by hydraulic motors. It is most common for a transporter travelling on soft soil, and the wheel starts to spin heavily. As a result, the tyres are bogged down, making the transporter unable to move forward. This problem can be overcome by innovating high powered hydraulic motors onto wheels, enabling the wheels to synchronise uniformly. Should the transporter skids, the hydraulic oil will be rerouted to other wheels, hence, preventing the transporter from bogging down.

The Grabber was first introduced by MPOB in the early 1990s and had become one of the most successful implement in improving worker's productivity. For this hydra-porter, a Grabber has also been incorporated to enable a one-man operation of evacuating the FFB.

DESIGN CONCEPT

This machine was built for transporting FFB from in-field to the main road. The design concept is simple and straight forward, to facilitate engineering fabrication, operator-friendly with low maintenance cost (*Figure 1*).

Figure 1. A schematic drawing of transporter.

Features

The machine has a single chassis, powered by a 38 hp water cooled diesel engine, coupled to a closed loop hydrostatics transmission. The front chassis house the engine and transmission pump while the rear chassis carry a bin with a full capacity of 750 kg. The front axle is hinged to the chassis and is able to swing 15 degrees, providing excellent ground contact when travelling over rough terrains. The machine is built to manoeuvre on steep slopes and slippery conditions. Overall, the machine is designed for simplicity, flexibility, manoeuvrability and low maintenance cost. This is the first hydrostatic driven wheel transporter.

Manoeuvrability

A steerable hydraulic motor which has been introduced into this transporter is currently a state-of-the-art technology in the field of agricultural transporters. It has a small turning angle compared to other single chassis machines with similar or longer length. Manoeuvrability between palms are much easier as the hydrostatics transmission requires less control linkages, hence, providing a smaller turning radius.

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Multi Range Transmission

The machine has the latest powershift transmission, which uses fluid as a mode of transmission to multiply the torque at any desired speed. The engine power is transmitted via a hydrostatics pump and then connected to motors at the four individual wheels, via a closed loop system. The selection of forward / reverse and low / high speed is done by a single lever control. This provides an excellent mean of power transmission when variable output speed and torque is required.

Low Maintenance Cost

The machine is designed for minimal cost in production and maintenance. Nevertheless, safety and reliability is not compromised. The parts and components are readily available in the market. The sub components are also cheap and available in the market.

With less mechanical components such as clutch, gearbox, power take off (PTO) and steering linkages, the machine should have less wear and tear, hence, reducing breakdown. Hydrostatics transmission that operates on oil under controlled pressure and temperature, provides a rather smooth drive compared to mechanical (shifting) gearbox, thus, minimising engine load under uncertain acceleration and de-acceleration.

FIELD PERFORMANCE TEST

The 4-wheel transporter was tested in the field to gauge its performance in the actual field plot. A 4 ha, 12 years old oil palm area at Ladang Bukit Bujang, Segamat, Johor was selected for the field test. There were 14 rows of palms, at 24 palms within a row. A total of nine collection trips was made during the field test. The 4-wheel transporter had to cover two harvesting paths or four palm rows in order to complete a collection trip. The time taken to complete one cycle and number of bunches per trip were recorded. The 4-wheel transporter operator directly dumps the payload for the collection trip onto the collection point at the roadside. *Table 1* summarises the time taken to complete one load of FFB while *Table 2* shows the productivity of the transporter on hourly basis. It took 12.70 – 14. 85 min to complete one cycle while the tonnes/hour is calculated based on average bunch weight, at an average of 20 kg per bunch. *Figure 2* shows the 4-wheel transporter during the field test. The achievable outputs for the 4-wheel transporter in the field were in the range from 20 and 25 t per day under the described conditions. The measured output was found to be very much dependent on the availablility of the bunches along the harvesting paths and space between them. The mean field total collection time per trip for the 4-wheel transporter was 13.7 min and its achievable mean capacity of 2.83 t hr^{-1}.

TABLE 1. MEANS FOR TOTAL COLLECTION TIME (trip per min)

Machine	Total collection time, min			
	Day 1	Day 2	Day 3	Mean
4-wheel transporter	14.85	12.70	13.88	13.67

TABLE 2. MACHINE OUTPUT (t FFB hr^{-1})

Machine	Machine capacity, t hr^{-1}			
	Day 1	Day 2	Day 3	Mean
4-wheel transporter	2.52	2.81	3.15	2.83

Figure 2. A 4-wheel transporter during field test.

ECONOMIC ANALYSIS

An economic analysis was carried out to estimate the operating cost of the 4-wheel transporter. The estimated total fabrication cost for the 4-wheel transporter was RM 85 000.

Assumption:

Machine price = RM 85 000
Economic life, E = 5 years
Productivity = 20 t per day
Working days per month = 25

Based on the above figure, the cost of in-field collection are:

Depreciation $\frac{\text{RM 85 000}}{\text{5 x 12 x 25}}$ = RM 56.67 per day

Repair and maintenance (10% of machine price per year), $\frac{\text{RM 8500}}{\text{12 x 25}}$ = RM 28.33 per day

Fuel consumption, 20 litres per day, @ RM 2.20 litre^{-1} = RM 44.0 per day

Labour cost = RM 60 per day

Hence, total cost is = RM 189 per day

Therefore, the operational cost of the machine is = RM 189/20
= RM 9.45 t^{-1}

The estimated total accumulated operating hours per year for the machine is 2400 hr based on a field operation of 8 working hours per day in 25 working days per month. Taking the machine ability to evacuate 20 t FFB daily with a machine price of RM 85 000, the expected in-field collection-transportation operating cost is RM 9.45 t^{-1}.

CONCLUSION

A 4-wheel transporter with the special feature of four hydraulically powered wheels was designed and developed. This hydrostatic drive transporter is suited for collecting and transporting oil palm FFB in difficult terrain and soft ground areas.

REFERENCES

ABD RAHIM, S; YAAKOB, H and MALEK, M (1989). Possible cost reduction and labour savings through mechanisation in Malaysia oil palm industry. *Proc. of the PORIM International Palm Oil Congress (PIPOC)*.

SAMSUDIN, S (2002). *Mekanisasi dan intergrasi ternakan lembu di ladang kelapa sawit – pengalaman Ladang RISDA Bera*. Hand out paper produced by RISDA during Mechanisation Field Day, Pahang.

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