HOVERCRAFT FOR IN-FIELD OPERATION IN OIL PALM ESTATE WITH SOFT GROUND AREAS

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The physical characteristics of peat soil limits its mechanization. Another limitation is the rising debris from the sinking of the soil. The protruding debris - old logs or stumps - obstruct the movement of machines and may also damage the under-carriage. Thus, it is important to consider seriously these limiting factors when introducing machines for peat areas.

The development of in-field machines for peat is difficult due to the additional constraints of the soil. Peat, being light, has an extremely low bearing load capacity, which may cause the machines to bog down. Thus, the machine must be as light as possible. Hence, there is a limitation to its weight and carrying capacity.

OBJECTIVE

To develop a hovercraft for transporting FFB in peat.

BENEFITS

- Enable mechanization on peat areas which are currently worked manually.
- Increase worker productivity.
- No ground contact, hence, no compaction and rutting problem.

DESIGN CONCEPT

An air-cushion vehicle, or hovercraft, is defined as a surface vehicle supported by a cushion of pressurized air. The cushion performs two basic functions; *viz*., to lift the vehicle off the ground, thus eliminating surface contact and the associated resistance, and to provide the vehicle with a suspension system. The principle is based on fan drawing air from around the vehicle and pumping it down under the hull. This air is contained within the skirt trapping it between the hull and ground. As soon as the pressure under the vehicle exceeds its weight, the vehicle will rise. Once the vehicle is clear from the ground, there is no friction between it and ground, and only a small thrust is required for movement. Under this condition, there is no ground contact, and virtually no ground pressure (*Figure 1*).

OTHER DESIGN CONSIDERATIONS

In addition, the following factors were considered:

- the machine can transport FFB from the field to roadside;
- the machine can also transport agricultural inputs such as fertilizers, chemicals and water for weed control; and
- simple to operate.

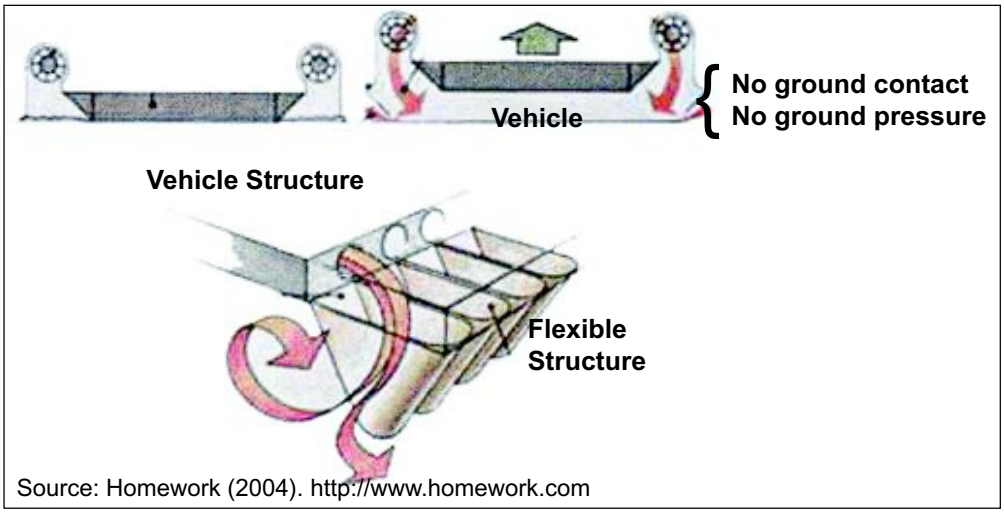

Figure 1. Principle of air-cushion vehicle.

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PROTOTYPE MACHINE

This machine incorporates special features to overcome the difficulties in mobility on peat soil as well as providing an alternative means for handling fresh fruit bunches (FFB) collection. The machine consisted of a flat-deck craft made from fibre reinforced plastic (FRP) with two engines mounted on board. These two engines are for lifting and providing thrust to the craft.

The prototype machine utilizes a bag skirt to contain compressed air when in operation. The engine for lifting enables the craft to hover at all times during loading and unloading FFB. The craft moves forward only when the throttle is applied on the thrust engine (*Figure 2*).

Figure 2. Prototype hovercraft vehicle.

Steering is controlled by a wheel linked by cable to a set of rudders just behind the thrust propeller. The FFB container is positioned in the middle of the craft and a reinforced vinyl bag is installed under the container to tilt the container. The exhaust gas from the thrust engine is channelled to the bag through a flexible hose and two butterfly valves are used to inflate the bag or to release exhaust gas. The pressure in the bag is enough to tilt the container with 500 kg load to the side of the craft. The container returns to its original position when the exhaust gas is released (*Figure 3*).

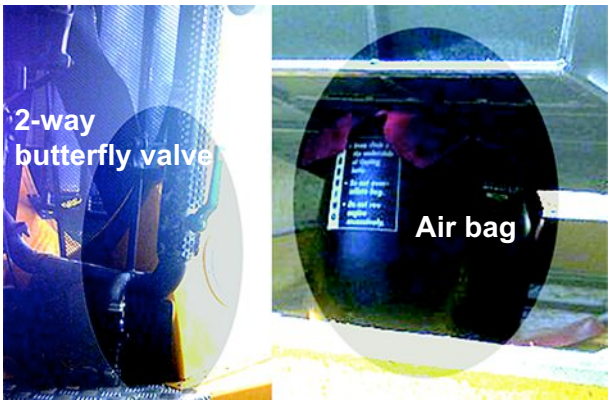

Figure 3. Tipping mechanism – control valve at the exhaust system to control air bag for FFB unloading.

Functional tests of the prototype were done prior to field trials in the estates *(Figures 4* and *5)*. From these tests, technical improvements were made.

FIELD TRIALS

Field trials were carried out in estates where this machine was most suitable. The trials were aimed at:

- assessing the machine's mobility and efficiency;
- establishing the machine's operating system;
- establishing its productivity; and
- monitoring its robustness.

The machine was tested on peat (*Figures 5* and *6*). From these trials, the productivity ranged from 12 to 15 t per day (eight effective working hours). Three workers were involved, one driver and two FFB loaders (*Table 1*).

Figure 4. Function test.

Figure 5. The machine being tested in the field.

Figure 6. Unloading the FFB at the roadside.

TABLE 1. COMPARISON OF PRODUCTIVITY BETWEEN MANUAL WORK AND HOVERCRAFT ON PEAT SOIL

	Productivity (t per day)	Price of transporter (RM)
Manual	average 1 t	-
Hovercraft	average 14 t	Estimate RM 80 000

It was found that:

- the machine performed well on peat, even in areas with a high water table;
- the machine was floating, hence, no ground contact which eliminated compaction or rutting; and
- the simple steering system contributed to good maneuverability.

PROFITABILITY

The hovercraft is more productive as well as generate more income to the estates compared to manual operated workers. On peat, the hovercraft can evacuate 14 t FFB per day per team compared to only 9 t FFB per day per team manually.

At an estimated FFB price of RM 200 per tonne and the machine life of eight years, with an operating cost of RM 42 per tonne, the estate income per month is RM 55 425 compared to RM 38 250 by manual. The worker's income per month can increase up to RM 1167 compared to RM 750 manually. Besides that, the number of workers can be reduced from nine to six workers (*Table 2)*.

CONCLUSION

The hovercraft is suitable for general in-field transportation on peat, either shallow or deep. It is suitable for FFB in-field transportation where the harvesting paths are fairly level and free from obstacles. The machine is able to reduce manual works as well as improve the productivity and income of the worker.

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TABLE 2. THE COMPARISON INCOME BETWEEN MANUAL AND HOVERCRAFT ON PEAT SOIL

Item	Manual	Hovercraft
Price of machine (RM)	-	RM 80 000
Economic life (yr)	-	8
Working days	25	25
No. of workers	9	6
FFB price per tonne (RM)	RM 200	RM 200
Operating cost	RM 30 per tonne	RM 42 per tonne
Labour cost (RM per tonne)		
Fuel, repair and maintenance and 10% unexpected factor (RM per tonne)		
Productivity		
Productivity per worker per day	1 t per day	2.33 t per day
Productivity per team per day	9 t per day	14 t per day
Productivity per team per month	225 t per month	350 t per month
Productivity per team per year	2700 t per year	4200 t per year
Net income		
Estate	RM 38 250 per month	RM 55 425 per month
Worker	RM 750 per month	RM 1 166.67 per month

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