

Design and Development of an All Terrain Crop Upkeep and Fresh Fruit Bunch Collection-Transportation Machine System for Oil Palm Plantation

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Introduction

Advancement for field automation-mechanization in oil palm plantation industry is hindered by the availability of suitable prime movers (basic vehicles) to suit the local terrain conditions. Without other options, tractors have been the widely used as prime movers in the plantation. However, tractors are designed to work on hard and flat terrains and not on undulating, soggy, and soft (peat) areas. They are designed as multipurpose prime movers to standard implement for field crops and not for tree crops (like oil palm and rubber). Consequently, the need to look into respective types prime movers with suitable machine attachments for various critical plantation field operations on hilly and undulating, coastal, and peat are urgently needed. The main objective of this research study is to conceptualise, analyse, and design a four-wheeled drive multipurpose prime mover for various infield operations on hilly and undulating areas and a segmented rubber track vehicle for oil palm fresh fruit bunches infield collection-transporting operation peat areas.

Materials and Methods

Problems with the available field machineries used in the oil palm plantations were identified. The design requirements of the proposed machine systems were then established to meet the field terrain condition and operational requirements in the plantations. Mathematical algorithms were developed to simulate and predict the significant of track and tyre design parameters on the traction performance of the prime movers. 3D conceptual designs of the proposed machine systems were developed using computer aided design software. 3D functional analysis on the proposed prime machine systems were conducted to simulated the machines operational functions. Detailed drawings, assembly drawings, and technical specifications of every component that built-up the proposed machine system were produced for the fabrication of the prototypes.

Results and Discussion

The wheeled type prime mover has a single chassis with skid steer drive wheels, oscillating drive axles, and low ground traction tyres and designed to operate on hilly and undulating inland areas. The tracked type has a single chassis with skid steer segmented rubber tracks and designed to operate on low bearing capacity terrain areas. Mounting provisions for the seedling transplanting, fertiliser applicator, spraying applicator, and the infield fruit collector-transporter were made on the prime movers. The respective implement attachments had been designed to have a payload capacity of 20 seedlings for field transplanting of palm seedlings, 600 kg load for crop fertilising, 450 litres fibreglass pesticide tank and 1500 kg load for the infield fruit collecting-transporting.

The configuration of the field transplanting of palm seedlings attachment consists of the seedling bin, drilling mechanism, and clamping-covering mechanism. The involved seedling transplanting operation includes preparing the planting hole, placing the seedling into prepared hole, covering the planted seedling and compacting the soil around the planted seedling. The configuration of the drill type crop fertilising attachment consists of the fertilizer hopper, furrow opener, metering and delivering unit, and covering device. The involved fertilizer operation includes preparation the furrow, metering and delivering of the fertilizer into the prepared furrow, and covering the fertilizer inside the furrow. The spread type crop fertilising attachment consists of the fertilizer hopper, metering unit, and spreading unit. The involved fertilizing operation includes metering and spreading the fertilizer on the palm circle surface. The configuration of the implement attachment consists of pesticides tank, sprayer boom, and hydraulic nozzles. The configuration of the infield fruit collecting-transporting attachment consists of the clamping unit, picker arm, and fruit bin. The involved infield collection-transportation operation includes clamping and lifting the FFB into the fruit bin, transporting the collected FFB, and dumping the transported FFB into the mainline transporter at the collection point.

Conclusions

Design concepts and technical specifications of a wheeled type prime mover and tracked type prime mover with various machine attachments for seedling transplanting, crop fertilizing, crop spraying, and fruit collection-transportation have been successfully developed for the oil palm plantation industry in Malaysia. Both the prototype prime movers and their associated machine attachments are currently under fabrication at our local workshop.

Benefits from the study

The introduction of a new improved machine systems that is cost effective, highly productive, and easily adaptable to local terrain conditions for various field operations in the Oil Palm Plantation Industry in Malaysia.

Patent(s), if applicable: 1. FFB Collector-Transporter , 2. Tree Crop Seedling Transplanter

Stage of Commercialization, if applicable: not yet

Project Publications in Refereed Journals

1. D. E. Pebrian and Azmi Yahya (2003). Design and Development of a Prototype Trailed Type Oil Palm Seedling Transplanter. *Journal Oil Palm Research*. 15(1): 32-40
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 3. Ali, M.E and A. Yahya. (2003). Design and Development of a Four Wheeled Drive Oil Palm FFB Collector- Transporter. *Journal Oil Palm Research* (Accepted to be published).
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 6. Ataur, R, Azmi, Y, Zohaidie, M, Ahmad, D and Ishak, W. (2003). Establishing Peat Mechanical Properties for Predicting Off-Road Vehicle Trafficability. *The Planter*. (Accepted to be published)
 7. D.E. Pebrian and Azmi Yahya. (2002). Comparisons on the Mechanics of Six-wheeled Drive and Four-wheeled Drive Prime Mover. *The Planter*, 77(909):723-745.
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 13. Ataur, R, Azmi, Y, Zohaidie, M, Ahmad, D and Ishak, W. (2003). Optimisation Design Parameters of Rubber Tracked Vehicle on Sepang Peat Terrain in Malaysia. *International Journal of Heavy Vehicle System*. (Accepted to be Published).
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 15. Ataur, R, Azmi, Y, Zohaidie, M, Ahmad, D and Ishak, W. (2003). Processes Involved in the Design of a Segmented Rubber Tracked Vehicle for Peat Terrain in Malaysia. *International Journal of Mechanical Engineering Education*, 2003. (under reviewed).
 16. Ataur, R, Azmi, Y, Zohaidie, M, Ahmad, D and Ishak, W. (2003). Parametric Study of Segmented Rubber Tracked Vehicle on Peat Terrain in Malaysia. *ASEAN Journal on Science and Technology for Development* (under reviewed).

Project Publications in Conference Proceedings

1. Ataur, R and Azmi, Y. 2002. Tracxon Mechanics of Rubber Track Vehicle on Sepang Peat Terrain in Malaysia. In: *Proceeding: Biological, Agricultural and Food Engineering of the 2nd World Engineering Congress*, Sarawak, Malaysia, 2002; p241-249.
2. Darius, E.E and Azmi, Y. 2001. Mechanized System for Field Transplanting of Oil Palm Seedling. In: *Proc. Nat. Conf. on Agric. and Food Mech.*, 2001; p 153-167.

3. Mustasim, A.A and Azmi, Y. 2001. Mechanized System for Infield Collection-Transportation of Oil Palm Fresh Fruit Bunches. In: Proc. Nat. Conf.on Agric. and Food Mech., 2001; p 168-178. *(Authors, year, title, full name of journal/ conference/ proceedings, volume, page numbers*

Graduate Research

Name of Graduate	Research Topic	Field of Expertise	Degree Awarded	Graduation Year
Mutasim E. Ali	FFB Collector-transporter	Bio-Production Machinery	Ph.D	2002
Darius El Pebrian	Tree Crop Seedling Transplanter	Bio-Production Machinery	M.S	2002
Ataur Rahman	Rubber Tracked Vehicle for Low Bearing Capacity Terrain	Bio-Production Machinery	Ph.D	

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