UNIVERSITI PUTRA MALAYSIA

A SINGLE CHASSIS INTEGRATED MACHINE SYSTEM FOR TRANSPLANTING OIL PALM SEEDLINGS

SIAMAK MOSLEHI ROODI

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By

SIAMAK MOSLEHI ROODI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

May 2011

Dedicated to

My Father Habib Moslehi Roodi
My Mother Tahreh Aram
My Wife Faezeh Yazdani, my child Hilda, and
Two my sisters and brother

Abstract of thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

A SINGLE CHASSIS INTEGRATED MACHINE SYSTEM FOR TRANSPLANTING OIL PALM SEEDLINGS

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Chairman: Azmi Yahya, PhD, PEng

Faculty : Engineering

The current technology employed by the plantation industry in the planting and replanting of oil palm seedlings are very laborious and time consuming. The whole planting operation involves many activities done inconsistently by workers. A single chassis integrated wheeled machine system was designed and tested for the planting of oil palm seedlings in plantations The identification and marking of planting points was done using a portable hand held Real Time Kinematic Global Positioning System (RTK GPS) unit. Field evaluation was conducted to determine the accuracy of using RTK GPS unit in laying the seedling planting points in the plantation field. The registered measurement spacing distance errors between adjacent planting points and between alternate planting rows are 5.1±0.020 cm and 0.40±0.022 cm, respectively. The two-man operated machine integrated all the 6 activities in a planting operation. The complete machine consists of a universal prime mover and a transplanter unit, with a configuration consisting of a seedling bin, support sleeves, planting assembly,

operator compartment and hydraulic system. This four wheel drive and four steer prime mover is equipped with a Kubota V-3300 4 cylinder water cooled 50.7 KW @ 2600 rpm diesel engine, Sauer Danfoss Series 40 axial piston main hydrostatic pump with 46cm^3/rev displacement @ 210 bar continuous pressure, oscillating front and rear axles, and 4 units of Bobcat heavy duty 12 ply 12-16.5 tires. The driver drives and then stops machine system at the already marked planting point in the field and the operator behind operates the hydraulic controls of the transplanter unit for the seedling planting operation. Upon completing the planting activities at the planting point, the driver then moves the machine system to the next planting point within the planting row and the operator repeats back the planting processes until all the planting points within the planting row were planted with the seedlings. Upon completing the planting operation for the planting row the driver moves back the machine to the nearby seedling supplying point for loading new batches of seedlings on to the machine system in order to continue back the planting operation on the next planting row. The machine system seedling bin is designed to accommodate a maximum of 28 palm seedlings per machine trip and this number of seedlings is enough to cater the number of available planting points within a planting row for any standard oil palm plantation layout in Malaysia.

Field evaluation and testing with the machine system shows this mechanized planting system has a planting capacity of 120 seedlings/man-day or 0.75 ha/man-day, and planting cost of RM0.84/seedling. The seedling planting in the oil palm plantation by using machine system required a total 7.90 Kcal/min-man human energy and the

current manual employed method of seedling planting in the oil palm plantation required a total 17.10 Kcal min^{-1} man^{-1} human energy. The human energy for machine system is 46 percent less than manual method. Assessment on the planting quality of the planted seedling shows percentage in planting success of 99.25%, leaning angles of 86.04±0.29 degree, spacing deviation of 5±4.14 cm, row alignment of 4.55±0.24 cm, and pulling forces of the planted seedlings to be 380.8±23.72 N. Conclusively, an increased in the planting capacity per man-day of 1.21 times with this machine system over the trailed type machine system while an increased in the planting capacity per man-day of 2.14 times was obtained with this machine system over the manual method. A planting cost reduction per seedling of 28.81 percent or cost saving of 0.34RM per seedling was obtained with the machine system over the trailed type system, and planting cost reduction per seedling of 44.37 percent or cost saving per seedling of 0.67 RM was obtained with the machine system over the manual method based on the field observation. The average total time moving machine system between planting points with RTK GPS was 118.58 second, and the average total time moving machine system between planting points without RTK GPS was 30.38 second.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan ijazah Master Sains

SEBUAH MESIN CASIS TUNGGAL BERSEPADU UNTUK MENANAM ANAK BENIH KELAPA SAWIT

Oleh

SIAMAK MOSLEHI ROODI

Mai 2011

Pengurusi : Ir. Azmi Yahya, PhD

Fakulti : Kejuruteraan

Kaedah dan teknologi semasa yang digunapakai dalam penanaman baru atau penanaman semula anak benih kelapa sawit oleh industri perladangan amat memenatkan dan melambatkan. Kerja keseluruhan penanaman melibatkan banyak aktiviti tunggal yang dilaksanakan secara berperingkat dalam jangkamasa tertentu oleh kumpulan pekerja yang berlainan. Sebuah sistem jentera bercasis tunggal, bersepadu, pacuan diri dan jenis beroda telah direka bentuk, dibina dan diuji untuk penanaman anak benih kelapa sawit dalam ladang. Penentuan dan penandaan titik penaman di ladang dilaksanakan dengn mengguna unit mudah alih Sistem Penentu Kedudukan Global Masa Nyata Kinematik (RTK GPS). Sistem jentera kendalikan dua orang ini menginterasikan kesemua 6 aktiviti tunggal dalam kerja penanaman dalam satu pergerakkan mesin. Sistem jentera yang lengkap ini terdiri daripada sebuah penggerak utama dan satu unit penanaman yang mempunyai konfigurasi yang terbina daripada satu bekas anak benih, pendokong gelonsor, pemasangan penanam , ruang operator,

dan sistem hidraulik. Penggerak utama empat roda pacuan dan empat roda stereng ini dilengkapi dengan enjin diesel Kubota V-3300 4 silinder pendingin air 50.7 kW@ 2600 psm, sebuah pam hidrostatik omboh paksi Sauer Danfoss Series 40 dengan 46 cc isipadu @ 210 bar tekanan terus, gandar roda depan dan belakang berayun, dan 4 unit tayer tahan lasak Bobcat 12 ply 12-16.5. Pemandu pandu dan memberhentikan sistem jenter di titik penansman yang bertanda dalam ladang dan operator di belakang menendalikan kawalan hidralik unit penanam untuk kerja penanaman anak benih. Selapas selasai aktiviti-ativiti penamanan di titik penanaman, pemandu mengerakkan sistem jentera ini ke titik penanaman berikutnya yang berada dalam barisan penanaman dan operator mengulangi semula proses-proses penanaman hingga kesemua titik penanaman dalam barisan penanaman selesai ditanam dengan anak benih. Seleapas selesai kerja penanaman untuk barisan penanaman tersebut, pemandu mengerakkan sistem jentera ini untuk kembali ke tempat pembekalan terdekat anak benih untuk memuat kumpulan anak benih baru ke dalam bekas anak benih dan seterusnya meneruskan penanaman pada barisan penanaman berikutnya. Bekas anak benih pada sistem jentera direkabentukuntuk membawa 28 anak benih bagi setiap perjalanan jentera dan bilangan ini adalah mencukupi untuk memenuhi bilangan titik penanamn yang terdapat dalm satu barisan penanaman bagi mana-mana bentangan piawai ladang kelapa sawit di Malaysia.

Penilaian dan pengujian ladang keatas sistem jentera ini memperlihatkan sistem mekanisasi penanaman ini mempunyai kapasiti penanaman sebanyak 120 anak benih/orang-hari atau 0.75 ha/orang-hari, tenaga input manusia sebanyak 7.90

Kcal/min-orang dan kos penanaman bernilai RM0.84/anak benih. Dengan menggunakan sistem mesin penenanam di ladang kelapa sawit memerlukan jumlah tenega sebanyak 7.90 Kcal/min-man dan penanaman biji benih secara manual di lading kelapa sawit memerlukan sebanyak 17.10 Kcal min^{-1} man^{-1} tenaga manusia di mana seperti yang di pelajari oleh Pebrian et. al (2010). Penggurangan tenaga manusia sebanyak 2.17 kali dalam Kcal/min-man di perolehi dengan system mesin berbanding cara manual.Penelitian keatas kualiti penanaman keatas anak benih yang tertanam menunjukkan kejayaan peratus penanaman bersamaan 99.25%, sudut kecondongan bersamaan 86.04±0.29 darjah, kelencongan jarak penanaman bersamaan 5±4.14 cm, kesejajaran barisan bersamaan 4.55±0.24 cm, dan kekuatan daya tarikan anak benih bersamaan 380.8±23.72 N. Kesimpulannya, satu peningkatan dalam kapasiti penanaman bagi setiap orang-hari sebanyak 1.21 kali diperolehi dengan sistem jentera ini berbanding dengan sistem jentera jenis tunda manakala satu pengingkatan dalam kapasiti penanaman bagi setiap orang-hari sebanyak 2.14 kali diperolehi dengan sistem jentera in berbanding dengan kaedah manual. Pengurangan kos penanaman setiap anak benih sebanyak 28.81% atau penjimatan kos sebanyak RM0.34 setiap anak benih diperolehi dengan system jenter ini berbanding dengan system jentera tanam jenis tunda dan pengurangan kos setiap anak benih 44.37 peratus atau penjimatan kos setiap anak benih sebanyak RM0.67 diperolehi dengan sistem jentera ini berbanding dengan kaedah manual berdasarkan hasil pemerhatian di ladang. Jumlah purata masa pergerakan system mesin di antara titk tanaman dengan RTK GPS adalah 118.58 saat, dan purata jumlah masa pergerakan system mesin antara titik tanaman dengan RTK GPS adalah 30.38 saat.

ACKNOWLEDGEMENT

First and foremost, the author wishes to thank all those whom had made this detailed design project possible, namely the faculty and also the department.

The author would like to express my sincere gratitude must surely go to my honorable supervisor, Associate Professor Azmi Yahya, PhD, PEng the chairman of the supervisory committee for his valuable advice, guidance and support in preparing and completing this design project report within the stipulated period. The author is also indebted and grateful to Dr. SamSuzana bt. Abd Aziz, member of the supervisory committee for her constructive comments, guidance and contributions.

Special thank is also due to Dr.Aimrun Wayayok from the Smart Farming Technology UPM for his endless yet worthy suggestion and knowledge related to this project, and laboratory technician, Encik Rushdi Zamri for his assistance and constructive advice during the experimental work. Special appreciations are extended to the colleagues in the machine design laboratory, Tajudeen, Payman Gassemi, and Darius, for their valuable assistance and contributions at various stages of the study.

Finally, the author wishes to thank his family in their helps and supports in many situations. And thanks are due to all those, whom I couldn't mention here, and who have contributed to the completion of this study through their physical, moral and spiritual support.

I certify that a Thesis Examination Committee has met on 26 May 2011 to conduct the final examination of Siamak Moslehi Roodi on his thesis entitled "A Single Chassis Integrated Machine System For Transplanting Oil Palm Seedlings**"** in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date:

DECLARATION

I declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently submitted for any other degree at University Putra Malaysia or other institutions.

SIAMAK MOSLEHI ROODI

Date: 26 May 2011

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