UNIVERSITI PUTRA MALAYSIA

MODIFICATION, PERFORMANCE AND ADAPTATION OF MANUALLY OPERATED TRANSPLANTING AND SEEDING MACHINES FOR LOWLAND PADDY

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By

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This thesis is dedicated to my "BORO MA" , a childless mother, without whose sacrifice, the author could be a fruitless flower.

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α	intercept for wet seeding model
β	estimated parameter coefficient for wet seeding model
δ	estimated parameter coefficient for wet seeding model
σ	estimated parameter coefficient for wet seeding model
ρ	bulk density (kg/m^3)
τ	shear strength (KN/m^2)
σ	compressive strength (KN/m^2)
φ	angle of internal friction of soil (degree)
ϕ	angle of repose (degree)
θ	cone included angle (degree)
@	at the rate of
A	area (ha)
B	diameter of orifice (mm)
c	soil cohesion (KN/m^2)
d	average diameter of spherical particle (mm)
D	depreciation (US$/yr)
d_1	major diameter of spherical particle (mm)
d_2	minor diameter of spherical particle (mm)
E_f	field efficiency (%)
F	shearing force (N)
g	acceleration due to gravity
ha	hectare
hr	hour
I	total interest (US$)
i	interest rate (%)
Kg	Kilogram
l	length of box (m)
L	expected economic life of a machine (Yr)
m	mass
P	purchase price of a machine (US$)

Q	flow rate of agricultural produce (gm/min)
R	replication
R^2	coefficient of determination
Rm	repair and maintenance cost (US$/Yr)
rm	repair and maintenance charge (% of P)
Rs	rupture strength (N/cm^2)
S	salvage value
Sb	volume of soil block (cm^3)
Se	effective field capacity (ha/hr)
Si	soil bearing index
Sib	volume of ideal soil block (cm^3)
S_t	theoretical field capacity (ha/hr)
Tk	Bangladesh currency (TAKA)
T_l	non-productive time
Tp	productive time
Tup	yield shear strength of unpuddled soil
Ui	uniformity index
US$	US dollar
V	total volume of sample (cm^3)
V_e	effective operating speed (Km/hr)
Vs	volume of settled soil (cm^3)
V_t	theoretical operating speed (Km/hr)
Wb	weight of soil block (gm)
W_e	effective working width (m)
Wib	weight of ideal soil block (gm)
Wt	theoretical working width (m)
X	independent variable
Z	dependent variable

LIST OF ABBREVIATIONS

AAAE	Asian Association of Agricultural Engineering
AMA	Agricultural Mechanisation in Asia, Africa and Latin America
BAU	Bangladesh Agricultural University
BRRI	Bangladesh Rice Research Institute
CRS	Cold Rolled Steel
cv	coefficient of variation
DF	Degree of Freedom
DMRT	Duncan's Multiple Range Test
DP	Degree of Puddle
FAO	Food and Agricultural Organization
FC	Fixed Cost
G.I.	Galvanized Iron
IAM	Institute of Agricultural Machinery
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
LSD	Least Significant Difference
M.S.	Mild Steel
MS	Mean of Squares
MTCP	Malaysian Technical Cooperation Programme
N.I.A.E	National Institute of Agricultural Engineering
ns	not significant
ODA	Overseas Development Agency
PAU	Punjab Agricultural university
PI	Puddling Index
PPC	Philippines Packing Corporation
RCB	Randomized Complete Block
S.E.D	Standard Error Difference
SS	Sum of Squares
UPM	University Putra Malaysia
VC	Variable Cost

Abstract of dissertation presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy.

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Chairman : Associate Prof. Dr. Ir. Desa Ahmad

Faculty : Engineering

An experiment was conducted for improvement of the 6-row manually operated rice transplanter designed by International Rice Research Institute (IRRI) to be adapted in the rice producing countries. After modification, a 5-row prototype was developed at the Bangladesh Rice Research Institute (BRRI), and both transplanters were evaluated and compared with hand transplanting method. A supplementary experiment was conducted to identify the optimum quality of the seedling mat for an improvement of the transplanter performance. Another experiment was conducted to improve the performance of IRRI designed drum seeder for lowland paddy. The machine was evaluated and compared with the hand seeding method.

The wooden skid of the IRRI transplanter was replaced by a skid made of G.I. sheet in BRRI transplanter which made it durable, light weight and incurred less sliding resistance. As a result, the dragging force for modified transplanter was

reduced by 30% compared to the previous prototype. The circular configuration of the picker finger of IRRI transplanter was modified to a semi-circular one which improved its cutting action.

The effective field capacities of IRRI transplanter, BRRI transplanter and the hand transplanting methods were 0.0155 ha/hr, 0.0191 ha/hr and 0.0023 ha/hr respectively. As a result, a 20% increase in working capacity was achieved with BRRI transplanter over IRRI transplanter. The field efficiencies of IRRI and BRRI transplanters were 76.83% and 78.90% which were similar, but that of hand transplanting method was 91.40% which was significantly higher than those of machine transplanting. Seedling per hill in machine transplanting was significantly higher than hand transplanting method due to excessive seedling density in the nursery. The missing hills in IRRI and BRRI transplanters were 3.81% and 3.66% respectively which were mostly identical but in case of hand transplanting method, the missing hill was nil. The rice yields from the fields planted by IRRI, BRRI and hand transplanting methods were not significantly different at 5% level.

An instrumentation system was developed to measure the rupture strength of seedling mat. After investigation, it was found that the rupture strength has an inverse relationship with the mat moisture content. The average values for the rupture strengths at saturation (45-50%), intermediate (30-35%) and friable range (20-25%) moisture contents were 3.21 N/cm^2, 4.21 N/cm^2 and 8.25 N/cm^2 respectively. The seedling mat with silty clay loam soil at a moisture content of 30-35% dry basis, produced the maximum value for soil bearing index (0.84) which was found better for crop establishment. The addition of saw dust to the mat soil decreased soil cohesion and consequently decreased the soil bearing index of the seedling block which was not helpful for crop establishment.

The cost of seedling production for 1 ha of land in the wooden frame, bamboo frame, plastic frame and nylon rope nurseries were limited to US$27.00 but in case of plastic tray that was US$45.00. However, for the wetbed nursery it was only US$19.00 per ha. The partial budget analyses indicated that machine transplanting with wooden frame, bamboo frame, plastic frame and nylon rope nursery seedlings produced the net benefits of US$13.48, US$19.46, US$16.05 and US$26.61 per ha respectively compared with hand transplanting method. On the other hand machine transplanting with plastic tray seedling incurred a net loss of US$35.20 per hectare compared to the cost of hand transplanting with wetbed nursery seedling (US$93.18 per ha). The break-even use levels per year of machine transplanting with wooden frame, bamboo frame, plastic frame and nylon rope nursery seedlings were 2.0 ha, 1.6 ha, 1.8 ha and 0.7 ha respectively and that with tray seedling was 13.00 ha.

The problem of unwanted seed dropping at the headland with the existing seeder was solved by incorporating a seed collector assembly which saved 5-7 kg of seed per hectare. The partial budget analysis revealed that by using drum type seeder and a rotary type weeder, a farmer could earn a net benefit of US$53.34 per hectare compared to hand seeding followed by hand weeding. The break-even analysis indicated that if a farmer has only 0.3 hectare of land, he could economically afford a drum type seeder and a rotary type weeder.

Abstrak dissertasi yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi syarat keperluan untuk ijazah Doktor Falsafah.

PENGUBAHSUAIAN, PRESTASI DAN PENYESUAIAN MESIN-MESIN PENANAM DAN PENABUR BENIH YANG BEROPERASI SECARA MANUAL UNTUK PADI SAWAH

Oleh

MD. SYEDUL ISLAM

September 1998

Pengerusi : Prof. Madya Ir. Dr. Desa Ahmad

Fakulti : Kejuruteraan

Satu eksperimen telah dijalankan untuk melakukan peningkatan terhadap mesin penanam 6-baris yang beroperasi secara manual oleh Institusi Penyelidikan Padi Antarabangsa (IRRI) untuk disesuaikan di negara-negara pengeluar padi. Selepas pengubahsuaian, satu prototaip 5-baris telah dimajukan di Institusi Penyelidikan Padi Bangladesh (BRRI) dan kedua-dua alat penanam telah dinilai dan dibandingkan dengan kaedah pemindahan tangan. Satu eksperimen tambahan telah dijalankan untuk mengenalpasti kualiti hamparan anak benih yang optimum untuk meningkatkan prestasi alat penanam tersebut. Kajian juga telah dijalankan untuk meningkatkan prestasi drum menabur benih rekaan IRRI untuk padi tanah rendah. Mesin ini telah dinilai dan dibandingkan dengan kaedah semaian tangan.

Papan gelincir kayu alat penanam IRRI itu telah digantikan dengan alat gelincir yang diperbuat daripada kepingan nipis G.I dalam alat penanam BRRI yang menyebabkannya tahan,ringan dan kurang rintangan gelongsor. Akibatnya, daya