Proceedings of the International Conference for Agricultural Machinery & Process Engineering
October 19-22, 1993, Seoul, Korea

DESIGN OF AN INFIELD TRANSPORTATION SYSTEM FOR COCOA PLANTATION

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ABSTRACT

An attempt was made to mechanize the infield transportation system in a cocoa plantation. A small trailer was designed and fabricated and used with a commercial 2-wheeled walking tractor modified into a 4-wheeled tractor-trailer unit to suit the plantation conditions. The transporter had a capacity of 800 kg and could be loaded with about 1000 cocoa pods at a time and was well within the towing capability of a 10 hp tractor. Time and motion studies were conducted on a 30 acre, 6 year old cocoa plantation intercropped with coconut to compare manual and the tractor-trailer combination in relation to infield transportation. The total time taken to harvest 80 trees manually was computed to be 24 manhours per hectare whilst the tractor - trailer combination required 18 manhours.

Keywords: Transportation, Cocoa

INTRODUCTION

Cocoa is one of the major crops in Malaysia, after oilpalm and rubber. The total area planted with cocoa has increased from 303,879 ha in 1985 to 423,200 in 1990. The total hectarage is expected to exceed 450,000 by 1995. Currently the smallholders sector accounts for 63.4% of the total cocoa acreage in Peninsular Malaysia. Research on high yielding varieties and usage of latest technology in cocoa production are greatly, emphasized as a consequence of government's encouragement in the National Agricultural Policy towards diversification of cocoa products. Nevertheless, due to the country's rapid industrialisation process, the cocoa plantation sector is also facing acute labour shortage in planting, harvesting and infield transportation systems as faced by the rubber and oilpalm plantations.

This paper highlights an attempt at overcoming the drudgery in infield collection and transportation of cocoa pods when intercropped with coconuts.

BACKGROUND INFORMATION

Planting System

Cocoa are normally planted in avenues of 9m apart while cocoa trees are planted in two rows three meters apart and equidistant from the coconut palms. Field drainage may pose a problem and hence a distance of 150cm from the edge of the drain is always maintained. This is to avoid trees falling over. High plant density allows selective thinning based on vigour and yield.

Harvesting and transportation systems

Currently manual labour is still being used fulltime to harvest and split the cocoa pods. Harvesting is normally organized on a three day cycle where two days are allocated for harvesting and one day for splitting the cocoa pods. Scatteurs are commonly used to harvest the fruits while splitting is done using a sharp knife, a mallet or a wooden block. Manually about 300 to 400 pods can be splitted in an hour.

Recently a mechanical method was devised with a capability of breaking and separating the seeds of 2500 cocoa pods per hour. (Abdul Razak Jelani, 1989).

The transporting of cocoa pods from the tree to the roadside has always been done by female and young workers carrying either basket or gunny sacks tied to a kandastick. A wheelbarrow is also a popular transport that can be loaded with 80 cocoa pods at a time. However, it is limited to flat terrain only. The use of big tractors is difficult due to planting distance and the height of cocoa trees. Furthermore 4 wheel tractors are heavy and expensive. Heavy tractors may compact the soil and damage the root system. The alternative is to use a lighter 2 wheel tractor (pedestrian tractor) which is cheaper and can be used for various other operations.

MATERIALS AND METHODS

The infield transporter consisted of a trailer which was designed and fabricated to be used in conjunction with a pedestrian tractor (Table 1). The trailer design took into account the characteristics of cocoa plant, field condition and planting distance. A body dimension of 1524mm x 1270mm x 500mm was selected based on the distance between rows.

The wheelbase between tractor and trailer was fixed at 2.7m, long enough to permit the location of load centre to lie ahead of the rear axle. The correct location of the load centre would ensure correct weight

distribution for the front and rear axles and result in safe operation, increase in payload and better manoeuvrability.

The location of load centre was calculated based on the formula suggested by James (1976) given as :

$$KP = \frac{WB \times \text{Payload of front axle}}{\text{Payload expected}} \quad \ldots\ldots (1)$$

where

KP = distance of load center of rear axle to centre the gravity
W B = wheelbase

The total rear axle load was determined using Eq. 2 given as

$$\text{Rear axle load} = \frac{\text{Payload} \times \text{load base}}{\text{Wheelbase}} + \text{unladen axle weight} \quad \ldots\ldots (2)$$

Based on the data given in Table 1, the distance of centre of load from the rear axle was 1.25m and the load on each tyre was 450kg. Using the load and inflation pressure from tables given by James (1976), the tyre size selected was 7.50 - 16 with 8 ply rating allowing a maximum load of 830 kg.

The main frame of the trailer was constructed from mild steel and assembled in part using screw joints. A hitching system made of hollow tubing provided the attachment to the tractor drawbar. The turning radius (radius of the arc described by the centre of the tractor-trailer made by the outside front wheel when making its shortest turn) was 2 meters. The tractor had 6 forward and 2 reverse speeds easily selected with only one shift lever, a maximum speed of 13km/h and a maximum capacity of 800 kg (about 1000 cocoa pods).

Time and motion studies were conducted on a 6 year old cocoa farm intercropped with coconuts. Manual harvesting was done using a scatteur whilst a wheelbarrow was used ot transport the cocoa pods to the road side. In the case of the tractor-trailer system, cocoa pods were loaded directly into the trailer after harvesting.

RESULTS AND DISCUSSION

Tables 2 to 4 show the results of time and motion studies between wheelbarrow and tractor-trailer combination for transporting cocoa pods to the roadside. For both experiments, harvesting and collection of fruits were done manually. Based on the results, the total time taken to harvest,

collect and transport the fruits to the roadside was 24 manhours per hectare. Cutting and collection took 44% of the total time whilst infield transporting with wheelbarrow took 56%. On the other hand, the tractor-trailer system required only 48% for collecting and transportation. This is equivalent to 18 manhours - a saving of 6 manhours.

CONCLUSIONS

The study had shown that a simple infield transportation system consisting of a pedestrian tractor and a trailer could reduce the harvesting time. The labour requirement, however, remained the same. As a load carrier, the trailer had a capacity of 800kg and was well within the towing capability of the 10hp power unit. The total cost of building the trailer was RM1,400 excluding labour charge.

ACKNOWLEDGMENTS

The author is grateful to Mr. Wong Chee Sang for conducting the field experiments.

REFERENCES

1) Abdul Razak Jelani. 1989. A preliminary observation on the performance of a prototype cocoa pod breaker and bean separator. Special Report, Faculty of Engineering, Universiti Pertanian Malaysia.

2) James, W.F. 1976. Motor truck Engineering Handbook. 2nd Edition, California.

Table 1 Tractor and engine specifications

Model		K 120
		(Center-driven rotary)
Measurement	Length	2290 mm
	Width	760 mm
	Height	1200 mm
Weight (without engine)		257 kg
Speeds	Forward	6 speeds
	Reverse	2 speeds
Standard tires		6 - 12
Brake		Inner expansion type
Main cluth		Dry multi-plate type
Steering clutch		Dog clutch
Power transmission system		Main shaft to wheel axle: Gear Engine to main shaft: 3V belts
Engine model		ER 900
Type		4 cycle diesel engine
Rated output ps/rpm		9.0/2,200
Maximum output ps/rpm		10.5/2,200
Fuel		Diesel heavy oil or light oil
Starting system		Double speed handle, manual
Cooling		Radiator type
Weight		109 kg

Table 2: Time and motion study on manual harvesting method for 80 trees

Operation	Activities	Time taken (s)	Total time (s)	%
Cutting	Cutting	2712	3048	44.0
	Movement in between trees	336		
Collecting	Collecting of cocoa pods	1440	3882	56.0
Infield transporting	Movement in between trees	408		
	Moving to the collection center	2034		
Total		6930	6930	100.0

Field condition : dry

Cocoa height : 3.3 meters

Cocoa harvested : 320 pods/80 trees

Cocoa age : 6 years

Slope : 14 - 25%

Table 3: Time motion study using tractor-trailer system for 80 trees

Operation	Activities	Time taken (s)	Total Time	%
Cutting	Cutting	2712	3048	52.3
	Moving from tree to tree	336		
Collecting and infield transporting	Collecting of cocoa pods	1440	2777	47.7
	Moving from tree to tree and to collection centre	1337		
Total		5825	5825	100.0

Table 4: Manhour comparison between manual and trailer assisted harvesting method

	@ Time taken (hr/ha)	
	Manual harvesting	Tractor-trailer
Cutting	10.6	10.6
Collecting and Infield transporting	13.4	7.5
Man hour/ha for the whole operation	24.0	18.1
No. of workers required	3	3

@ Calculated based on 4 cocoa pods/tree and 400 trees/hectare