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A Mechanized Tool for Mango and Coconut Harvest

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Tractor mounted hydraulic elevator (TMHE), a mechanized tool, has been developed and tested for harvesting of mango and coconuts. The exhaustive field-testing of TMHE on mango and coconut orchard was conducted on plane and sloppy land upto 20.5 per cent slope on University farm and farmers' field. The comparative study of available elevator for mango and coconut harvesting has been studied. The cost of TMHE is Rs 1,30,000. The observed field capacity of the developed TMHE is 2800 mango (700 kg) per day and 4,524 coconuts/day.

(Key words: *Tractor mounted hydraulic elevator, Biometric parameters, Harvesting time, Coconut, Mango)*

The area of producing horticultural fruits in Maharashtra state in 2006-07 was 73000 ha. Konkan region is the narrow strip of 40 km width and 750 km of length from North to South is a hilly terrain lying between Sahyadri ranges in the east and Arebian Sea in the West. The production of coconut in Maharashtra state is 273 million nuts during 2006-2007. The Konkan region is located 15° 36' to 20° 21' North latitude and 7°7' to 74°13' East longitude. The region is comprised of four districts viz. Thane, Raigad, Ratnagiri and Sindhudurg. The hilly terrain receives heavy rainfall ranging from 2000-4000 mm per annum. The climate is hot and humid almost throughout the year. The climatic conditions are suitable for growing various fruit crops. The total geographical area of the region is 29.5 lakh hectares, out of which 9.5 lakh hectares have been brought under cultivation of different crops. Land under forest is 5.54 lakh hectares, arable land is 5.34 lakh hectares, land put to non-agricultural uses in 1.93 lakh hectares, cultivable waste land is 3.85 lakh hectares, permanent pastures and other grazing land is 1.19 lakh hectare and land under miscellaneous crops is 0.47, fallow land 3.08 lakh hectare and net sown area 8.39 lakh hectares.

Konkan region is well known for the horticultural fruits like mango, sapota, coconut, cashew, konkam, etc. However, these horticultural fruits like mango (Alphanso variety) and coconut (T/Dvariety) are preferred for their better test and more uniformity. The manual harvesting of these fruits is drudgerious and time consuming. During peak season, it is very difficult to get required number of skilled labours. Manually operated tree climbers was developed during 1980s have some operational problems and limited safety for harvesting coconuts. It also requires adequate skill and training. Manually operated low capacity gadgets and tree-shaking methods also prevail, which are time consuming, drudgereous, damaging to fruits and tree branches. The fruits should not be allowed to fall on the ground as the injured fruits cause spoilage to other healthy fruits.

Harvesting of coconuts in India is mostly done manually by means of curved knife, pair of scissors or blades attached to a hanging basket towards one end of a bamboo sticks (Devnani, 1980). In countries where there is shortage of skilled labour the nuts are not harvested and allowed to fall of their own accord and the fallen nuts are collected from the ground at intervals (Thampan, 1983). In Sri Lanka, harvesting of coconut done from the ground with the help of a knife attached to a long bamboo pole. Coconut harvesting by this device is very difficult for the tree of more height, and only trained persons can operate it. The Tractor mounted hydraulic elevator for the horticultural fruits was remodeled for the harvesting, spraying and pruning of horticultural fruit trees (Kolhe and Dhande, 2008).

MATERIALS AND METHODS

The biometric parameters of tree like tree height, tree crown, average yield etc of coconut nuts and mango were considered for the development of Tractor mounted hydraulic elevator (TMHE). Accordingly, the different machine components are fabricated and assembled together at Dr. B.S. Konkan Krishi Vidypeeth, Dapoli. The design was conceptualized by considering farmers needs and

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available equipments in the market as input following the concepts of engineering like Product concept, design engineering, drafting, process planning, production scheduling, quality control etc. Some physical features of mango and coconut tree where this machine was used are given in table 1.

Table 1. *Physical parameter of tree for development of THME*

Specifications	Mango (Alphanso)	Coconut (T\D)
Spacing between two trees (m)	10	7.5
Tree Height (avg. of ten replications) m	10	15
Tree Canopy radius (avg. of ten replications) m	3	2
Tree Age, (avg. of ten replications) year	25	12
Number of fruits/tree.	250	100

Design Procedure

The above TMHE is designed by studying the horticultural trees biometric parameters of the horticultural trees. The total height of lifting mechanism is finalized considering the height of trees upto 12.20 m. The lengths of lower and upper links are fixed 4.00 and 4.50 m respectively. The experimental load lifting capacity of the tractor mounted hydraulic elevator is 5,886 N including the live and dead load. However the theoretical load lifting capacity of the elevator is 9810 N. The factor of safely was 1.6, which indicates the safe operation.

Development of TMHE

The turntable of the elevator is mounted on the three-point linkage of the tractor. The equipment comprises a hydraulic pump, hydraulic motor, a tank, flow control valve, hydraulic cylinder, direction control valve, the harvesting link, harvesting bucket. The hydraulic pump is driven by tractor PTO. The oil is pumped to the cylinder 1 and cylinder 2; however one end of the cylinder is attached to the turntable and other end to the lower link. The one end of cylinder 2 is connected to that link and its second end is attached to another link. The flow of oil for both the cylinder controlled by the direction control valve. The oil is pumped by hydraulic motor to lift the two links. The up-down motion upto 15 m height and the rotary motion upto 360° (180° in each direction) is provided to the link AB, CD and the turn table. The machine was comfortably used for harvesting mango fruits upto 15 m height (ground clearance 1 m + maximum reach of elevator 7.80 m + operator reach 2 m + reach of mango harvester 3.20 m). The design permits 360° rotation of the elevator link about its longitudinal axis. The link absorbs some reactive force of the elevator without causing excessive vibration of the link when the elevator is in operation. The link and the turntable action is controlled by the valve and its pressure on the link is controlled by an adjustable relief valve. The material for the above fabrication work is as per ASTM specifications and metal joining process are selected according to the thickness of the metal plate to be joined (Kolhe and Datta, 2007). The Tractor mounted hydraulic elevator is used for mechanical harvesting of mango and coconut trees. The experiments were conducted to decide the maximum load capacity of the elevator maximum reach position to lift the load. The research was conducted on mango trees and coconut trees at University farm of Alphanso and T/D variety respectively. The testing was held in the month April - May 2008 for mango tree and for the month of February – March 2009 for coconut trees.

The supporting wheel of 30 cm diameter, 4 cm width and 6 mm thickness is designed and developed for the better stability of tractor-mounted elevator in field. The total live load of TMHE in operating condition is balanced by the supporting wheel. The wheel is designed in such a way that the position of this wheel can be easily adjusted in sloppy land. During field-testing of the machine these modifications resulted in better stability of the elevator. The maximum load of 600 kg can be placed in harvesting bucket in maximum reach position without affecting the tractor stability. The slope of land was measured by using level tube at various locations.

RESULTS AND DISCUSSION

The biometric parameter of coconut tree, the maximum and minimum height and stem girth noted for the coconut (T/D) variety are 640 cm, 1080 cm and 77 cm, 126 cm respectively are presented in Table 2. From the above, significant relation is observed between the tree height and steam girth of coconut trees. The different coconut distribution and coconut maturity time for tree to tree for the same age group tree are noted. These changes in biometric parameters are due to the soil condition, fertilizers and water distribution for the tree and uneven atmospheric condition. The results of the hydraulic elevator for mango and coconut harvesting are shown in table 3. The harvesting time and the number of coconut harvested for different trees are changed from tree to tree. Hence there is no significant relation between the harvesting time,

Table 2. *Biometric parameters and Machine performance of coconut Orchards*

Sr. No.	Tree No.	Biometric parameters			Machine performance			
		HOT (m)	SG (cm)	CD (cm)	HST (min.)	HCT (min.)	TRH (min.)	CHPT (min.)
1	54	7.50	96	8.90	8.45	8.50	5	10
2	55	6.70	89.5	9.10	8.50	8.55	5	39
3	56	8.40	101.5	9.70	8.55	8.60	5	23
4	89	6.30	115.5	10.60	8.60	8.62	2	5
5	90	8.90	99.5	9.30	8.63	8.65	2	14
6	161	8.0	106	9.90	9.13	9.14	1	11
7	162	7.30	108.5	8.30	9.14	9.15	1	22
8	163	7.40	116	10.60	9.16	9.19	3	31
9	164	7.20	88	9.20	9.19	9.22	5	34
10	197	7.20	92	8.20	9.25	9.26	1	12
11	200	6.5	77	8.90	9.28	9.30	2	2
12	233	7.80	91	9.30	9.31	9.33	2	17
13	234	7.30	126.5	9.10	9.34	9.35	1	20
14	235	6.40	97.5	10.10	9.38	9.39	1	2
15	236	10.20	103	11.20	9.39	9.40	1	12
16	269	7.90	98	9.30	10.32	10.37	5	12
17	270	9.10	115.5	10.10	10.37	10.40	3	19
18	271	9.45	121.5	9.90	10.41	10.45	4	27
19	272	10.80	101	8.60	10.45	10.48	3	5
20	306	8.10	99	9.60	10.49	10.52	3	16

Table 3. *Performance of the hydraulic elevator for mango and coconut harvesting (avg. of three replications)*

Sl. No.	Particulars	Mango	Coconut
1	Period of trials, day	1	1
2	Number of fruit harvested per hr	350	377
3	Number of fruit harvested per day	2800	4,524
4	Weight of fruit harvested, kg/hr	87.5	—
5	Capacity of Hydraulic elevator (kg/day)	700	—
6	Capacity of hydraulic elevator (No. fruits per day)	2800	4,524

harvested nut and tree height for the coconut tree due to variations in fruit maturity period, number of nut, and tree height varying from tree to tree. The TMHE can be economically and piously used for harvesting of coconut and other orchard fruits. The coconuts were harvested from one-hectare area in one day.

Performance of machine on slope

The machine performance including hydraulic start time, hydraulic close time, time required harvesting coconut and number of coconut harvested per tree is shown in table 2. From the above table 3, the number of coconut harvested per hour is 377 coconuts per hour. The 13-coconut tree is comfortable harvested by using this TMHE in one hour. The hydraulic elevator can be comfortably operated on plane land. The performance of machine on sloppy land was tested at different slopes ranging from 2.6 per cent to 20.5 per cent. Beyond 12 per cent slope, instability was observed i.e. front lifting of tractor. Hence beyond 12 per cent slope of land, the elevator was operated in reverse direction. It was comfortably operated in reverse direction upto 20.5 per cent slope. Hence machine should be operated on the sloppy land up to 12 per cent slope in forward direction and for 12- 20.5 per cent in reverse direction.

Table 4. *Comparison of developed elevator with AAU and TNAU elevator*

Sl. No.	Particular	AAU elevator	TNAU elevator	Dr. BSKKV elevator
1	Harvesting, pruning, and spraying operation	Manually	Manually	Manually
2	Lifting mechanism	Semi automatic	Semi automatic	Automatic
3	Movement of machine platform	Vertical with inclined	In vertical plane	180° on each side
4	Machine mounting source	Tractor trolley	Ground with three point linkage	Tractor three point linkage
5	Number of trees covered from one location	One	One	Four
6	Maximum lifting height	7.5 m	9.5 m	12.20 m

Field performance of the machine

Fruit harvesting : The hydraulic elevator was evaluated for harvesting the mango and coconut from trees. The details of the results are shown in table 2. The machine was comfortably used for harvesting the mango fruits upto 15 m height (Ground clearance 1 m + maximum reach of elevator 7.80 m + operator reach 2 m + reach of harvester 3.20 m) ii) Tree pruning: - The hydraulic elevator was used for pruning operation up to 10 m height comfortably using the saw.

Comparison with the other tractor mounted elevator

It was observed that the traditional elevator could lift vertically up and down movement and required additional mounting device for the elevator. The operation of these elevators in field will be difficult. The comparisons of available elevator with the developed elevators are presented in Table 4.

It was found that the elevator developed at Dr. B.S. Konkan Krishi Vidyapeeth (Dr. BSKKV) is more suitable for mango and coconut harvesting and other orchard works like spraying and pruning upto 15 meter and pruning of tree upto 10 meters height. The hydraulic elevator is suitable for operation on plain field as well as hilly terrain having slope upto 20.5 per cent.

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