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Performance evaluation of a manually operated cotton picker

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Cotton harvesting/picking may be accomplish manually or mechanically using cotton picker. A manually operated cotton picker was developed and on-farm performance evaluation was carried out. The cotton picker was compared with the existing manually operated cotton picker, and the traditional method of harvesting cotton on the bases of time input, labour requirement, ground and plant harvest losses. Results indicate that labour requirement for the developed cotton picker; the existing cotton picker and manual cotton picker were 166.17, 173.8 and 93.3 man-hour-ha^{-1} respectively. With their respective ground harvest losses of 15, 12 and 5% at the branch moisture content of 39.5% wet base and cotton moisture content of 2.8% wet bases. The study also indicates that time input, labour requirement, ground plant harvest losses were statistically significant at 5% level.

Key words: Cotton picker, picking, efficiency, picking losses, manual.

INTRODUCTION

Importance of cotton in Nigeria

Cotton has been grown in Nigeria for many centuries to meet the need of the local spinning and weaving industries (Mustafa et al., 1968). Among the several different types of cotton introduced into Nigeria for research purposes was “Allen long staple” an American upland type (*Gossypium hirsutum*), a onetime popular variety in parts of the United States of America for its high quality. It came to Nigeria from Uganda in 1912 (Mustafa et al., 1968). This cotton proved better and adapted very well to the local Nigerian farming condition such that subsequent improvements were easily made from it. This lead to what is known as “Nigerian Allen” and later the “Samaru Allen” from which satisfactory levels of yield resistance to diseases and pest as well as high lint’s quality were obtained. It was from this seed that improved varieties such as Samaru 26C, Samaru 26J, Samaru 68, Samaru 70, Samaru 72 and Samaru 77 were obtained (Jones, 1968). Later in the sixties many cultivars and strains/varieties were introduced into Nigeria from different parts of the world to aid the cotton research programme. Some of these cultivars possessed very distinctive characteristics such as high lint quality, high yield, resistance to pest and diseases and early maturity. These were used to develop the current commercial varieties of cotton (Jones, 1968).

Generally, the entire cotton growing regions are divided into three zones based partially on climatological and other related conditions. These divisions are:

1. Northern cotton zone comprises of Kano, Kaduna, Katsina, Sokoto, Kebbi and Jigawa States.
2. Easter cotton zone comprises of Borno, Bauchi, Adamawa, Yobe and Taraba States
3. Southern cotton zone comprises of Kwara, Niger, Kogi, Oyo, Osun and Ondo (Gbadegesin and Uyovbisere, 1994)

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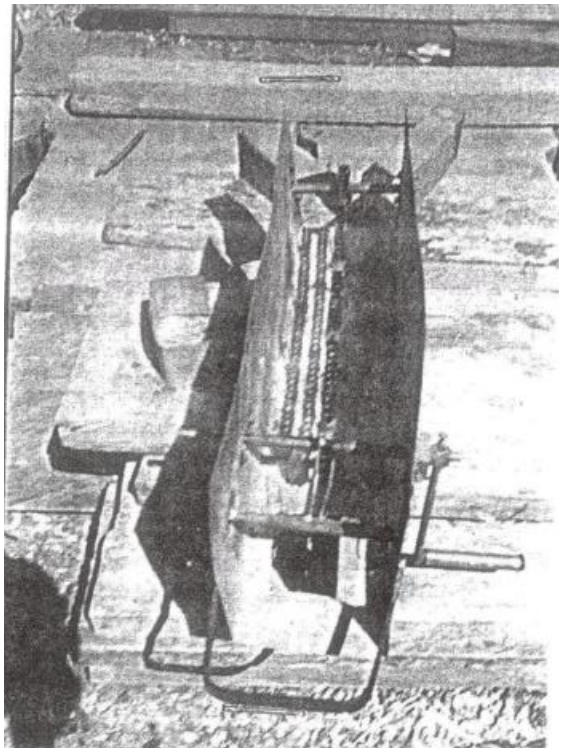

Figure 1. Top view of the manual cotton picker.

With all these improvements in the quality of cotton and the increase in the output of cotton, there was an establishment of mills for spinning and weaving of cloths. The total output of cotton was so high that there was need for export of the product to earn foreign exchange (Mustafa et al., 1968). Apart from meeting the need of weaving industry, exportations was enhanced and other use for the cotton seed was also developed which is, the extraction of oil from the seed. The cotton oil seed is very rich in mineral content. The oil in cotton seed is 35% protein (Hui, 1992). The cotton seed left after extraction of oil is the meal which is completely edible to ruminants and monogastric animals. As such it is used as protein additive to animal feeds (Monogastric animals). It is used to provide raw materials for our cloth industries and the lint is used to spin thread which is used for sawing. It provides employment in cotton ginning industry. Cotton is the most important raw material for textile industries and it is used extensively in medicine and surgery for dressing wounds. The oil is also used as carriers for agriculture sprayers and the by-product from the refining process are used in soap manufacturing. It is also used as a source of fatty-acids (Hui, 1992).

Economic importance of cotton

About 20 million tons of cotton are produced each year in about 90 countries. China, United States, India, Pakistan, Uzbekistan and West Africa account for over 75% of global production (Internet document). Cotton represents nearly half the fibre used to make clothes and other textiles worldwide, with much of the rest coming from synthetic products.

U.S. textile mills presently consume approximately 7.6 million bales of cotton a year. Eventually, about 57% of it is converted into apparel, more than a third into home furnishings and the remainder into industrial products.

Objectives

1. To carry out on farm evaluation of a developed manually operated cotton picker.
2. To compare the performance of the machine with an earlier developed manually operated picker and the traditional method of cotton picking.
3. To assess its adaptability

Justification

Manual harvesting of cotton is drudgery prone and time consuming. Pate et al. (1963), Mechanical harvesting of cotton is limited to large scale farmers in Nigeria because they are the only ones who can afford these machines. This make the production of this vital commodity limited to very few hands. Even the few large scale cotton producers who have these machines spend a great deal of their cost in maintaining them. This is equally not making it economical for them to be in the production of cotton Prentice (1972).

Description of the cotton picker

The cotton picker consists of picking finger which are fixed to the chain. They are fastened to the chain by brazing on a sheet metal which is brazed to the chain. The fingers are made of three pieces of wire of length 5 cm each. A throttle wire is used because it has a springing effect which is needed in the operation of the picking fingers. The chain is driven by two shafts (OD = 55 mm each) the shaft at the picking end of the machine passes through a bearing (ID = 25 mm) fitted with a casing. The crank handle is connected to the shaft at the power end. Human power is transmitted to the machine for cotton picking operation by the sprocket and chain arrangement, the spikes are fitted in front of the fingers at the rear end of the machine to disengage the picked cotton which then fall by gravity through the passage provided on the casing Smith and Wilkes (1976) . A hanged bag to casing serves as the collection point. Three ground wheels (one in front and two at the rear) are provided to carry the assembled components of the machine. The pictorial view of the machine cotton picker is shown in Figures 1 and 2.

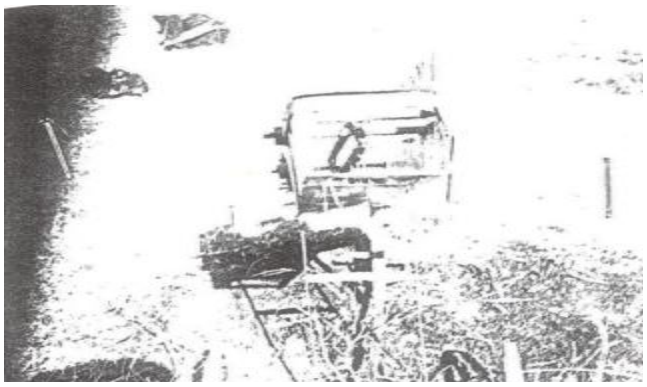

Figure 2. Pictural view of the cotton picker.

Table 1. Table of subjects data.

Subjects	A	B	C
Sex	Male	Male	Female
Age	26	18	19
Occupation	Secondary school leaver	Student	Student
Height (m)	1.8	1.6	1.8
Health condition	Good	Good	Good
Body weight (kg)	57	54	58

Figure 3. Cotton picker been used on the field.

RESEARCH METHODOLOGY

The harvesting efficiency, timeliness, and energy/power utilization by the operator/user of the cotton picker was evaluated on the field (Figure 3). The experimental field of Faculty of Agriculture in A.B.U. Zaria was used for the test. Three subjects were used for the test and their personal data was taken. The table of the data of the body condition of the subjects is shown in Table 1.

The time taken to harvest all the cotton stands contained in each ridge was measured using stop watch for both traditional hand method and mechanized method using both the existing and the improved version Bates (1963).

During the test the necessary time of operation of each of the subjects using the options were taken and their body conditions such as pulse rate before and after were taken Saidu (1990).

Evaluation criteria for the manually-operated cotton picker

The layout of the test field was such that planting of cotton was done in inter-row width of 120 cm and the inter-row distance between plants was 90 cm as recommended by Prentice (1972) to increase the efficient operation of the machine. The plant height between 45 and 60 cm fall within the working range of the

Table 2. Harvesting test result showing losses and labor requirements.

Data no.	Branch moisture content (% w.n)	Cotton moisture content (% w.n)	Field area covered	Time Input (min)			Labour requirement (man-hour-ha^{-1})			Ground harvest loss (%)			Plant harvest loss (%)		
			(m^2)	Mech^1	Mech^2	Man'^{1}	Mech^1	Mech^2	Man'1	Mech^1	Mech^2	Man'1	Mech^1	Mech^2	Man'1
1	57.8	2.8	50	92.50	105.0	67.50	308.3	350.0	225.0	17	13	10	19	18	5
2	37.2	2.7	50	125.0	128.0	68.00	416.6	426.6	226.7	15	12	5	17	15	3.5
3	58.4	2.9	50	165.0	170.0	92.00	550.0	566.6	306.7	10	8	5	18	16	10
1	39.5	2.83	50	50.00	56.15	38.00	166.7	173.8	93.3	15	12	5	14	12	12
2	41.6	1.86	50	85.00	93.00	71.00	283.3	310.0	236.7	15	8	7	13	10	7
3	36.4	2.35	50	115.0	118.0	98.30	383.3	393.3	326.3	17	14	9	11	10	5
1	33.4	1.73	50	100.0	120.4	64.00	333.3	401.3	180.0	10	9	10	12	10	8
2	31.5	2.04	50	62.5	66.38	30.00	208.3	221.6	100.0	11	10	9	16	15	7
3	34.6	2.3	50	70.00	74.45	48.00	233.3	238.1	116.7	10	10	10	15	13	6

M^1 = Test result from the developed cotton picker; M^2 = Test result from Asota (1990) machine (existing machine).

machine in order to reduce field losses during harvesting. Two system of cotton harvesting, (i) manual system (manual picking of cotton with hands) and (ii) mechanical system (mechanical picking by the developed manually-operated cotton picker) were considered. Parameters such as ease of operation, machine efficiency, moisture content, field losses, energy expenditure and labour requirement were determined. The performance of the manually-operated cotton picker in terms of these parameters was evaluated and compared with manual system to evaluate the improvement in the performance of the developed machine and its feasibility for adaption (Table 2).

RESULTS AND DISCUSSION

The performance evaluation was carried out when majority of the bolls (about 80% of the total crop) were opened to reduce field losses and increase the quality of the cotton harvested. According to cotton improvement conference (1963), cotton should be 75 to 80% matured before picking/harvesting. In the field where cotton stands are unharvested for 4 to 6 weeks, losses in fiber and seed quality are increased. The machine was made to operate at an average forward speed of 1m/s, higher speed could result to dirty cotton and increase in cotton losses Basil and Geoge (1955).

Analysis of field results

The result from the field tests have shown that the developed manually operated cotton picked had lower average labour requirement of 320.34 man-hour-ha^{-1} as against then average labour requirement of 342.37 man-hour-ha^{-1} recorded for the existing machine. However the lowest average labour requirement of 201.27 man-hour-ha^{-1} when the cotton moisture content was 2.8% (w.b.) was obtained for the manual picking of the cotton. The differences in their means were statistically significant at 5%. Similar trends in the results were obtained for other moisture level considered. However, there was no comparative advantage of the developed cotton picker over the existing machine in terms of ground and plant harvest losses (Tables 3 to 5).

Conclusions

1. The developed manually operated cotton picker had an efficiency of 60%.
2. Lower labour requirements were recorded for the developed manually operated cotton picker over the existing cotton picker.
3. There was a time input of 105 min when

Table 3. Paired sample t-test value of significant between machines 1 and 2 in terms of time input, labour requirement, ground harvest loss and plant harvest loss.

Performance characteristics	t-test (cal.)	t-test [Tab.(0.05)]	t-test[tab.(0.01)]	Remark
Time input	-3.86	2.31	3.36	**
Labour requirement	-3.19	2.31	3.36	*
Ground harvest loss	3.90	2.31	3.36	**
Plant harvest loss	3.35	2.31	3.36	*

Machine 1 = after modifications; Machine 2 = before modifications; * = statistically significant at 5% level; ** = statistically significant at 1% level.

Table 4. Paired sample t-test value of significant difference between machine 1 and hand picking in terms of time input, requirement, ground harvest loss plant harvest loss.

Performance characteristics	t-test (cal.)	t-test [Tab.(0.05)]	t-test[tab.(0.01)]	Remark
Time input	4.64	2.31	3.36	**
Labour requirement	5.46	`2.31	3.36	**
Ground harvest loss	4.16	2.31	3.36	**
Plant harvest loss	6.60	2.31	3.36	**

Machine 1 = after modifications;** = statistically significant at 1% level.

Table 5. Paired sample t-test value of significant difference between a manual cotton picker and hand picking in terms of time input, labour requirement, ground harvest loss and plant harvest loss.

Performance characteristics	t-test Cal.	t-test, Tab.(0.05)	t-test, tab.(0.01)	Remark
Time input	5.63	`2.31	3.36	**
Labour requirement	6.08	`2.31	3.36	**
Ground harvest loss	3.25	`2.31	3.36	*
Plant harvest loss	3.71	2.31	3.36	**

Machine 2 = before modifications; * = statistically significant at 5% level; ** = statistically significant at 1% level.

using the existing cotton picker in an area of 50 m^2. This time was reduced to 93 min when using the developed manually operated cotton picker on the same area of field.

RECOMMENDATION

The manually operated cotton picker can be improved for greater efficiency, increase in field capacity and speed of picking using a fuel (petrol or diesel) powered engine. Improvement can be made in the picking width by increasing the picking fingers in such a way that two rows can be picked at a time. With this improvement a specific planting space and ridge spacing will have to be used on the field. All these will reduce total time needed to work on a field and the man-ha-$hour^{-1}$ value of the machine. Speed of picking will also be enhanced if a fuel (petrol or diesel) powered engine replaces manual operation.

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