MODIFICATION AND PERFORMANCE EVALUATION OF KAU PEPPER THRESHER

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PROJECT REPORT

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Faculty of Agricultural Engineering & Technology
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Malappuram

1993

DECLARATION

We hereby declare that this project report entitled **Modification and Performance Evaluation of KAU Pepper Thresher** is a bonafide record of project work done by us during the course of project and the report has not previously formed the basis for the award of any degree, diploma, associateship, fellowship, or other similar title of any other University or Society.

30/10/93

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30th Oct., 1993.

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RAVIKUMAR, C.

CERTIFICATE

Certified that this project report entitled **Modification and Performance Evaluation of KAU Pepper Thresher** is a record of project work done jointly by **Sri. Ambujan, C.V.** and **Sri. Ravikumar, C.** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to them.

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SYMBOLS AND ABBREVIATIONS USED

Agrl.	-	Agricultural
ARS	-	Agricultural Research Station
C/C	-	Centre to Centre
Dept.	-	Department
et al.	-	and other people
Fig.	-	Figure
HP	-	Horse Power
ICAR	-	Indian Council of Agricultural Research
i.e.	-	that is
ISAE	-	Indian Society of Agricultural Engineers
IS	-	Indian Standard
J.	-	Journal
KCAET	-	Kelappaji College of Agricultural Engineering & Technology
kg	-	kilogram
km/h	-	kilometre(s) per hour
kg/min	-	kilogram(s) per minute
kg/s	-	kilogram(s) per second
Ltd.	-	Limited
m	-	metre(s)
min	-	minute(s)
MS	-	Mild Steel

NARP	-	National Agricultural Research Project
No.	-	Number
pp	-	pages
rpm	-	revolution per minute
Rs.	-	Rupees
s	-	second(s)
SAC	-	Supportive and Allied Course of Study
t	-	tonne(s)
Tech.	-	Technology
/	-	per
%	-	per cent

INTRODUCTION

The success of Indian Agriculture has been the envy of many developing countries. The increased production that has been realized during the recent past must be credited to a large extent to the increased use of high yielding varieties, irrigation facilities, fertilizers, better crop management and also to the effective utilisation of machines and implements in agriculture. Contributing about 34 per cent of the national income, agriculture serves the major exchequer of our country and employment to millions.

India produces and exports almost all spices. Major spices like pepper, cardamom, ginger, turmeric and chillies are the most important items in the foreign trade. Spices form an important item of our export earnings.

Among the major spices of India, black pepper occupies a prior position in terms of production and income. Reigning supreme over the descrening all over the world, pepper has been rightly acclaimed 'THE KING OF SPICES'. It comes from the fruit of a climbing vine botanically known as Piper nigrum. The fruits which are small berries carried on slender spikes ripen for harvest between November-January. When

PEPPER SPIKES

mature the berried are hand picked carefully, threshed and sun dried.

The world production of pepper is estimated to be about 70-80 thousand metric tonnes of which more than 90 per cent is accounted for by India, Indonesia, and Sarawak, Combodia, Ceylon, Brazil and Malagasy Republic are the other countries which produce pepper. More than 250 thousand acres are now under pepper cultivation in India and the annual production ranges between 4049 thousand tonnes (Anon, 1993). Indian pepper is imported by more than 85 countries of the world. Indian export during 1971-72 which was 19, 254 metric tonnes valued about Rs.150 million increased to 130567 tonnes valued about Rs.362.04 crores in 1991-92. The quantity of pepper exported and its value from 1987 to 1992 are furnished in Table 2.

There are many handicaps in production and processing of black pepper in India. Even though the quality of our black pepper, which is the most important item in the export, is superior to pepper produced in foreign countries we are unable to sell our produce at the same rate as sold by others due to high cost of production in our country. Quite often the exported pepper contained foreign materials such as, mud, animal excreta and other type of contamination.

Labour is the costliest single input in pepper cultivation contributing to about 80-90 per cent. The wages of agricultural labourers have increased tremendously while there was only a marginal increase in the price of pepper. It was very difficult to get sufficient number of labourers especially during the periods of harvesting and threshing, now a days.

Threshing is one of the critical post harvest operation in the processing of pepper. Adoption of improper threshing methods results post harvest losses thereby reducing the not recovery of black pepper.

The conventional method of pepper threshing in treading under human feet. The berries get separated from the stalk by shearing action. This traditional method of threshing is uneconomical, time consuming and laborious.

Mechanical threshers clearly have an edge over conventional ones as they may reduce the drudgery of work to a great extent. These mechanical threshers may increase the level of performance and are economical too.

A prototype model of a pepper thresher (KAU Pepper thresher) was developed at Agricultural Research Station, Mannuthy in 1987 as an NARP Project. The above model worked satisfactorily. However this was a hand operated model and

having low capacity. In the present study an attempt was made to modify the above KAU pepper thresher, so as to increase its efficiency and capacity. The major objectives of the present study were:

1. Modification of the KAU Pepper thresher for increasing its efficiency and capacity.
2. Performance evaluation of the modified Pepper thresher.

Table 1. Production and exports of major spices

Item	Production 1990-91	EXport 1991-92	Value Rs. (Crores
Pepper	48980	20565	74.21
Cardamom small	5750	553	16.07
Cardamom large	4400	932	4.76
Chillies	691000	3398	97.91
Ginger	148520	13396	20.32
Turmeric	347800	16565	31.57

Table 2. Pepper exports from India

Year	Quantity exported (MT)	Value (Rs. crores)
1987-88	4101	240.57
1988-89	36981	164.63
1989-90	34482	152.96
1990-91	29,985	102.40
1991-92	20565	74.21

A brief review of the general characteristics of black pepper (Piper nigrum), processing of black pepper, different types of threshers used, conventional and mechanical threshing methods etc. are presented in this chapter.

Piper nigrum is native of Western Ghats in India. Pepper is one of the oldest spices used big man. It has been widely introduced through out the tropics but the three main producers are India, Sarawak in Malaysia and Indonesia.

2.1 Structure of the crop

Piper nigrum is a perennial glabrous woody climber to 10 m or more in height. Under the best cultivation when the height is restricted, the mature vine has a bushy colunnar appearance and is about 4 m high. The pepper plant has 10-12 main adventitious roots from the base of the mature stem which penetrate up to a depth of 1-2 m and there is an extensive mass of surface feeding roots (Purseglove, 1968). Both Blacklock (1954) and Dewaard (1964) mention the shallow root system. On both the climbing and fruiting branches the leaves are alternate and simple, with a petiole 2 to 5 cm long, which is grooved above. The fruit is a sessible, globose drupe 4 to

6 mm in diameter, with a pulpy pericarp, borne in spikes 5 to 15 cm long.

2.2 Harvesting and yields

Vines are not usually permitted to produce flowering spikes until they are at least 2 years old. It takes some 150 days to 200 days from flowering until harvesting.

Harvesting in Kerala taken place from November to February. Towards the end of the harvest period the vines are stripped of all fruiting spikes and the ripe and unripe fruits produced are made in to black pepper.

Krishnamurthi (1969) reported that there are usually two crops in India, one in August-September and other in March-April.

2.3 Processing

The two major primary products of Pipper nigrum that are internationally traded are black pepper and white pepper. The former is prepared from drying the pepper berries as such without any change and the latter is produced by removal of mesocarp of the mature berry.

Black pepper is produced from whole, unripe but fully developed berries. In India and some other countries

harvesting is also done when the green berries commenced to acquire a yellow colouration or to some what more advanced stages of colour development.

Harvested berries are then threshed by conventional method, which is treading under foot and then sun dried for 7 to 10 days, during which the moisture content is reduced to 10 to 15 per cent. Govindarajan (1977) reported that some trials with through flow hot air dryers were conducted in India, but sun drying is more common now also. The yield of dried black pepper is around 36 Kg from 100 Kg fresh berries.

2.4 Threshing

According to Trivedi and Arya (1965), threshing may be defined as the group of operations that are designed to detach the desired product from the mass of the harvested crop materials and their separation from the mass.

According to RNAM (1983) threshing is the first post harvest operation for separating the grain. It is generally laborious.

The pepper spikes consists of a long stalk and the pepper berries which are attached to the stalk. The separation of berries from stalk is termed as pepper threshing.

2.5 Principles of threshing mechanisms

Kepner et al. (1987) reported that threshing may be accomplished by

(i) impact of a fast moving member upon the material

(ii) rubbing

(iii) squeezing pods

(iv) a combination of two or more of these actions or

(v) some other method of applying the required forces

Many different types and configurations of threshing devices have been deviced, but very few have reached the stage of even limited field use.

2.6 Threshing methods

Common methods of threshing are

(i) Manual threshing

(ii) Animal threshing

(iii) Mechanical threshing

Manual threshing

Threshing is done by manual labour. It is the conventional method followed by most of the pepper cultivators in India. Under this, the harvested berries are treading under human foot and the shearing action separates the berries

CONVENTIONAL METHOD OF PEPPER THRESHING

from stalks. It is laborious and time consuming, which has a numerous disadvantages also.

2.7 Power driven threshers

According to Pradhan (1968) and Johnson (1969) power driven threshers are becoming popular due to the following reasons.

(i) unavailability of sufficient labourers during the harvest season.

(ii) quick and time saving.

(iii) some improved varieties are more difficult to thresh by the traditional methods.

(iv) minimises the grain loss

(v) even small quantity of crop can be threshed separately without deterioration of the quality.

Power paddy threshers can be classified based on the feeding methods as:

(i) Hold - on type
(ii) Throw - in type

In hold on type method of threshing, paddy straw is held stationary while threshing is done by the impact on the panicle from cylinder bars, spikes or wire loops.

In throw in type, the plants are completely fed in to the machine. These machines are equipped with threshing cylinder, concave and have some separating and cleaning mechanisms.

2.8 Threshing methods used for pepper

(i) Treading under foot

It is the conventional method followed by most of the pepper cultivators in India. Under this method, the harvested berries are treading under human foot and the shearing action separates the berries from the stalks. It is a laborious and time consuming method, which has a numerous disadvantages. They are:

a. Drudgery
b. Contamination with foreign materials
c. Low export value

(ii) Mechanical threshers

Mechanical threshers clearly have an edge over conventional ones as they reduce the drudgery of work to a

great extent. Mechanical threshers increase the level of performance and are economical too.

A hand operated pepper thresher was developed at ARS, Mannuthy (Mathew, 1987). It was the first attempt that was reported on pepper threshers. The approximate capacity of the pepper thresher was 60 kg/hr.

MATERIALS AND METHODS

This chapter includes the general description of the existing KAU pepper thresher, the modification details of this pepper thresher for improving its efficiency and capacity and the methods involved in the performance evaluation of the modified pepper thresher.

The existing pepper thresher was a hand operated one. And its hopper and some other parts are found to be less effective. Hence the existing hand operated black pepper thresher had to be modified for making it more efficient.

The following are the primary requirements, of the power operated pepper thresher.

1. It should ensure smoother operation with lesser vibration and friction
2. It should have high output or capacity
3. The power requirements should be minimum
4. It should have mechanism for declogging
5. It should be cheaper to fabricate and easy to operate
6. The components of the thresher should be detachable and maintenance should be minimum
7. It should be simple in construction

Keeping the above points in mind the K.A.U. Pepper Thresher was modified.

3.1 Existing KAU Pepper thresher

The existing KAU Pepper thresher was designed and fabricated at Agricultural research station. Mannuthy in 1987 as a NARP Project work. The above pepper thresher was a hand operated one. It is in good working condition. That was the first attempt in the development of pepper thresher. Low cost, small in size, simple operation, portability etc. are its peculiarities. The machine consisted of the following parts.

1. Frame

The size of the frame is 675 mm x 405 mm x 1100 mm. It was made of M.S. Angle Iron 25 mm x 25 mm x 2 mm size welded together to the required size.

2. Hopper

A hopper is provided at the top for the purpose of feeding unthreshed pepper spikes into the thresher. Cross-section of the hopper is 305 mm x 305 mm having a height of 240 mm. It was made of 14 gauge GI sheet.

EXISTING KAU PEPPER THRESHER

3. Threshing drum

The diameter of the drum 285 mm and its breadth was 178 mm. It was attached on a 3/4" rod in such a way that the drum could be bined or replaced as required. This MS rod function as a shaft. The shaft was fixed on the frame in such a way that it could freely rotate. The right portion of the shaft was provided with a pin to connect and dismantle the handle and drum while operating the drum by means of handle of the shaft. The drum was covered with rubber sheet having a rough surface.

4. Concave

A concave made of 16 gauge MS sheet and shaped to get a semi circular shape. This surface was is also having a rubber sheet cover. The size of the MS sheet used to make the concave was 765 mm x 190 mm. On this concave sheet a number of 6 mm holes were made. The threshed pepper grains passed through these holes and the spikes were collected in a converging unit, which is the grain receiver. Provisions were also made to adjust the clearance between the drum and concave. Threshing was achieved by the shearing and frictional forces acting on the pepper spikes when they pass between the rotating drum and stationary concave.

5. Converging unit

The pepper berries obtained through the small holes on the concave are collected in this unit. This is made of M.S. sheet of 14 gauge. The converging unit is having a slope towards the outlet from where the berries can be collected.

6. Feeding chute

Feeding chute is an important part of the pepper thresher through which the pepper spikes are fed and guided to the threshing cylinder during threshing. The fabricated feeding chute consists of the following parts (a) Bottom which receives the pepper spikes (b) Side which guides the pepper spikes (c) Top cover which restricts the length of arm inside the feeding chute during threshing.

7. Covering plates

The drum and concave were covered at sides by means of MS plates of 16 gauge of size 360 mm x 360 mm. It not only functioned as a cover to the rotating drum but also confined the pepper within the required space. The burries and spikes got separated and were delivered in opposite directions from where they were collected separately.

8. **Shaft**

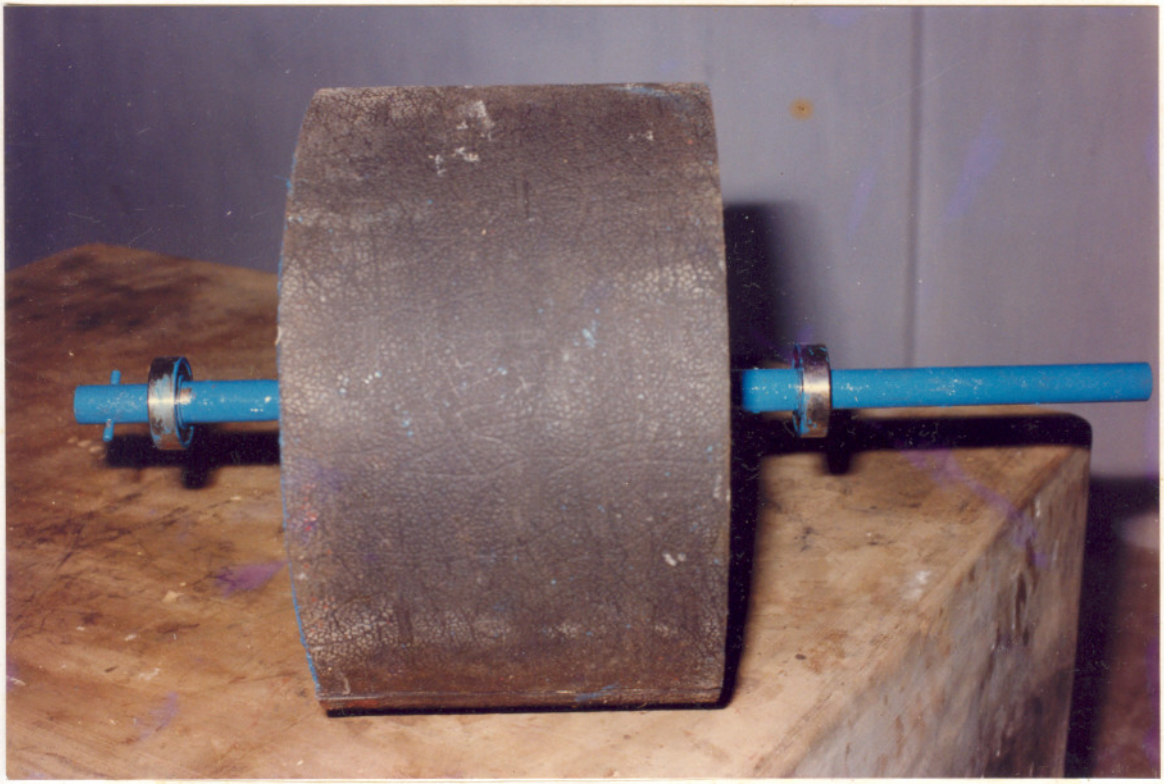
A hollow circular shaft having 20 mm diameter was fixed on the frame by means of ball bearings. The threshing drum was fixed on the shaft. On the right side of the shaft provisions were made to fix a detachable handle and on the left side provisions were made for converting the unit to a power operated one. The centre to centre between the bearings was 313 mm.

3.2 Modification of KAU pepper thresher

While modification the following factors were considered.

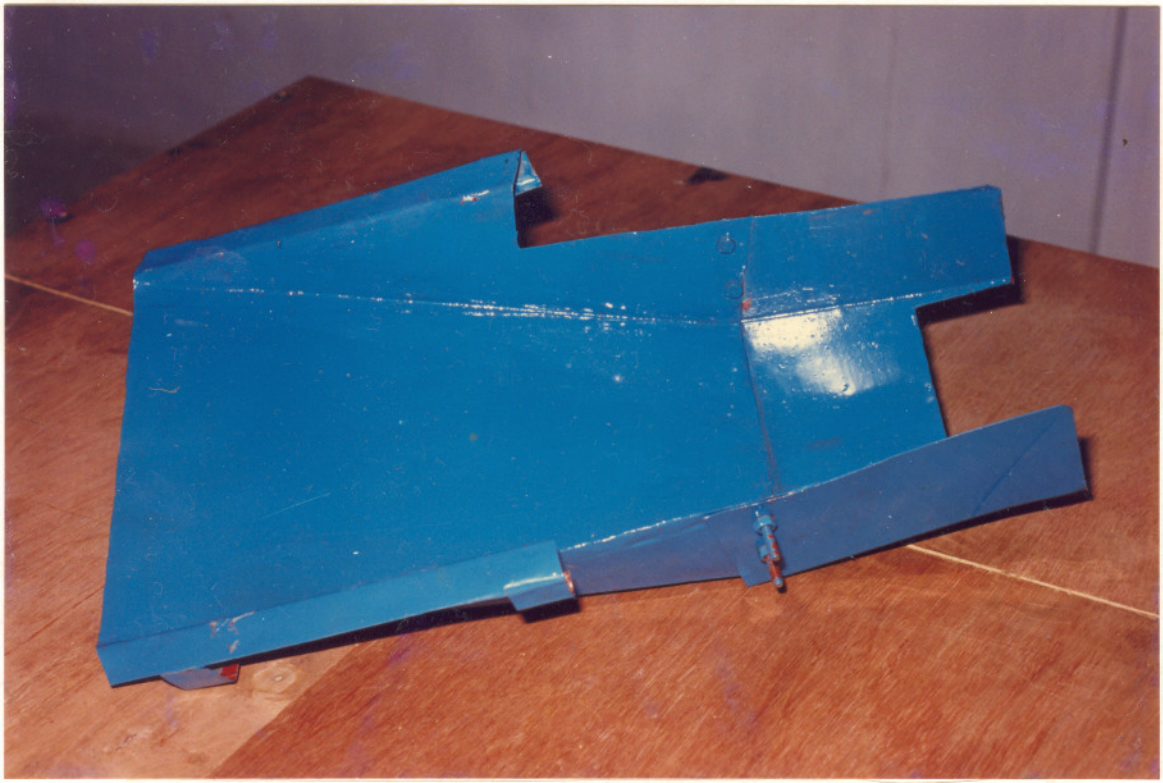
1. Cost of threshing must be low
2. Operation should be easy, simple and safe
3. Energy consumptions, if any, should be minimum
4. Thresher must be durable
5. Damages if any, must be minimum
6. Thresher should have provisions to operate with manual power and electric power
7. It should take less floor space
8. Maintenance works required should be minimum

MODIFIED KAU PEPPER THRESHER



PARTS OF THE MODIFIED KAU PEPPER THRESHER - THRESHING DRUM

PART OF THE MODIFIED KAU PEPPER THRESHER - CONCAVE UNIT



PART OF THE MODIFIED KAU PEPPER THRESHER - FEEDING CHUTE

MODIFIED PEPPER THRESHER UNDER OPERATION

3.3 Performance evaluation of the modified pepper thresher

3.3.1 Capacity determination of modified pepper thresher

Weighed samples of black pepper was used for the determination of the capacity of the thresher. The pepper was fed through the feeding chute. The time taken for threshing the sample was noted. The experiment was repeated several times and the average capacity in kg/hr was determined.

3.3.2 Determination of threshing efficiency

In order to determining the efficiency of threshing few pepper spikes were selected. The number of berries on the spikes were counted and each one was marked separately. After threshing the berries left on these marked pepper spikes were noted. The threshing efficiency was found by using the equation

$$\text{Threshing efficiency} = \frac{\text{Number of berries removed after threshing}}{\text{Number of berries on the spike before threshing}} \times 100$$

RESULTS AND DISCUSSION

The results of the performance evaluation of the modified KAU Pepper thresher is presented in this chapter. The capacity of the thresher, efficiency of the thresher, economic aspects and suggestions for further developments are given in this chapter.

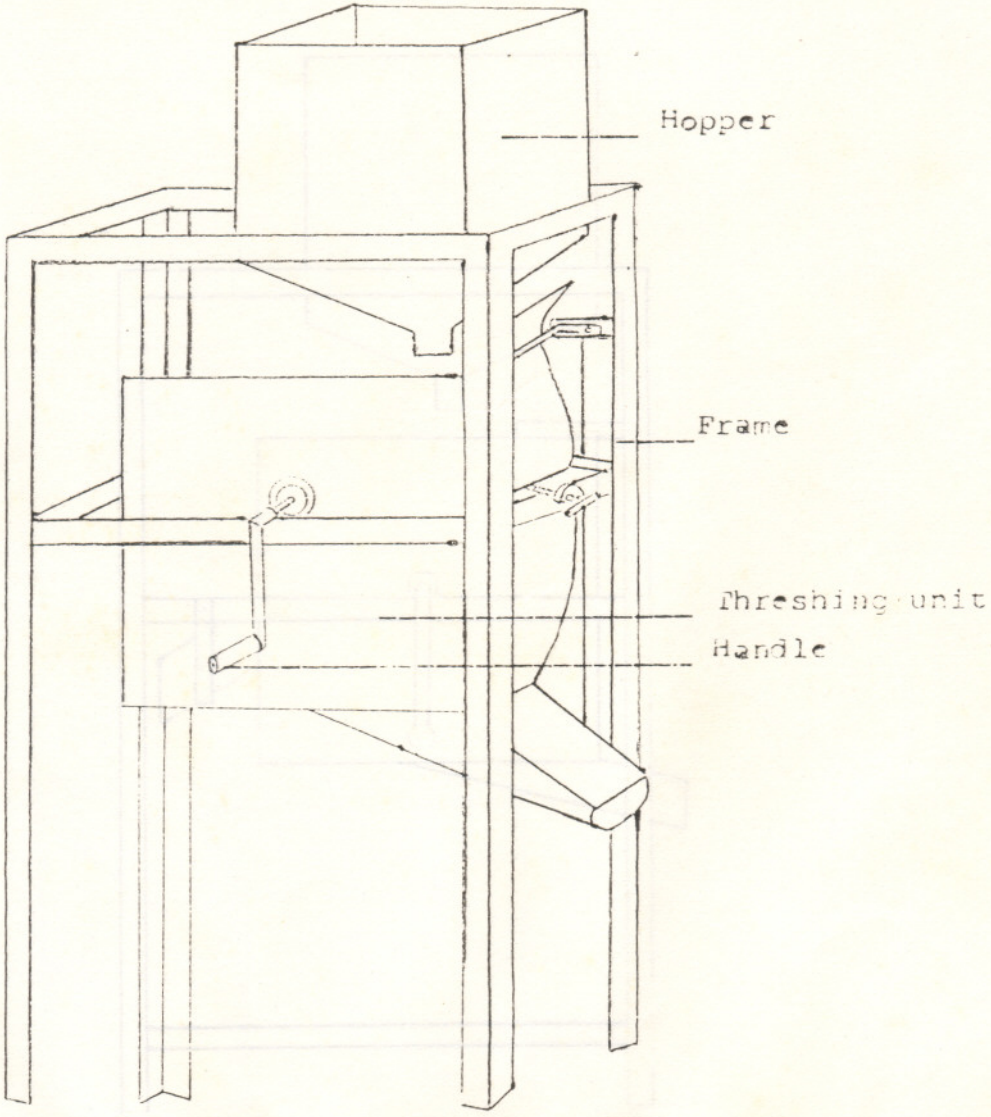
4.1 Determination of capacity of the pepper thresher

Weighed samples of black pepper was used for testing. This pepper was fed through the feeding chute. The time taken for threshing the sample was noted. The experiment was repeated four times. The results are tabulated in Table 3.

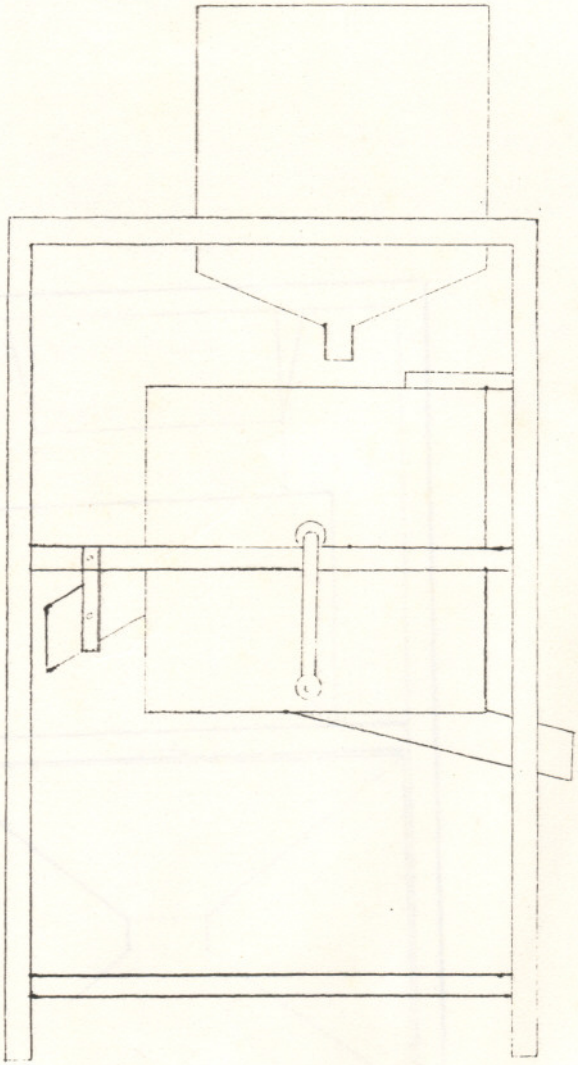
It is seen that the average capacity of the modified pepper thresher was slightly lower than the original unit. This may be due to the fact that the pepper spikes used were not fully matured at this time.

4.2 Determination of threshing efficiency

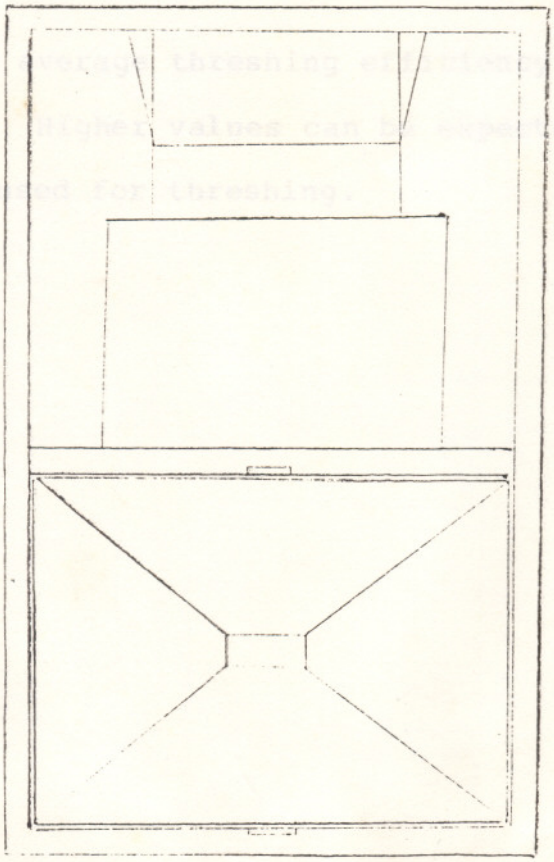
In order to determine the efficiency of threshing, few pepper spikes were selected. The number of berries on the spikes were counted and each one was marked separately. After threshing the berries left on these marked pepper spikes were noted. The results are shown in Table 4.



ISOMETRIC VIEW OF THE EXISTING KAU PEPPER THRESHER



ELEVATION OF THE EXISTING KAU PEPPER THRESHER

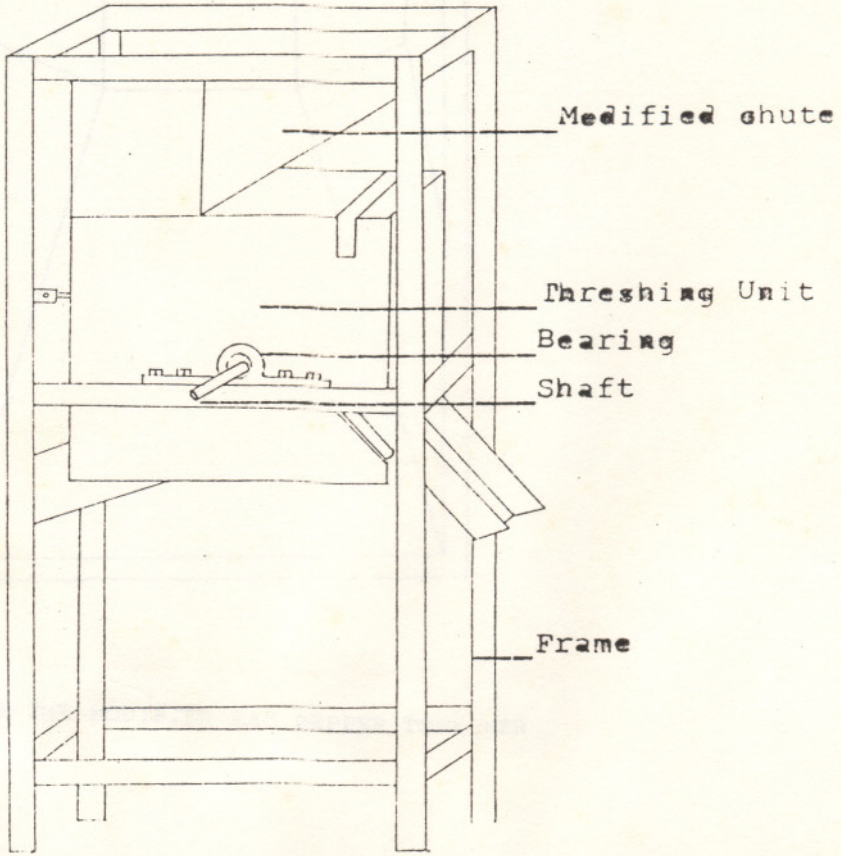


PLAN OF THE EXISTING KAU PEPPER THRESHER

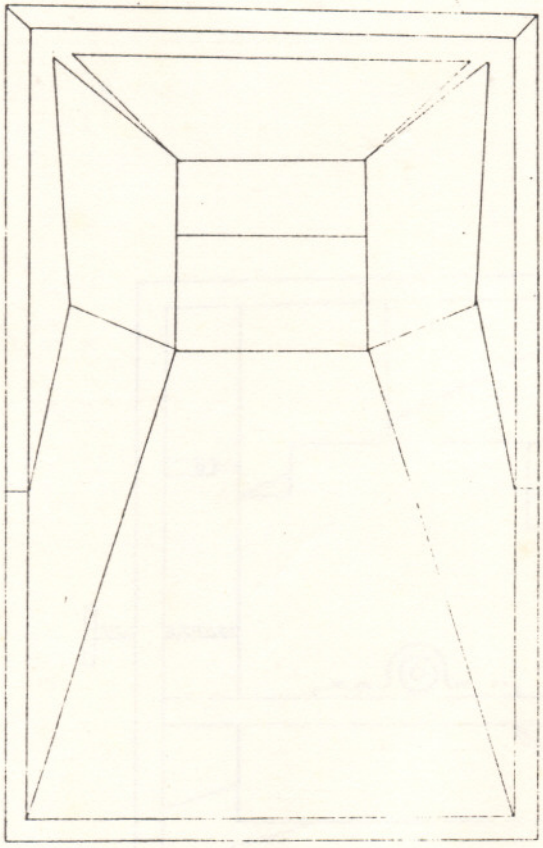
The threshing efficiency was found by the following equation

$$T.E. = \frac{\text{Number of berries removed from the spikes after threshing}}{\text{Number of berries on the spike before threshing}} \times 100$$

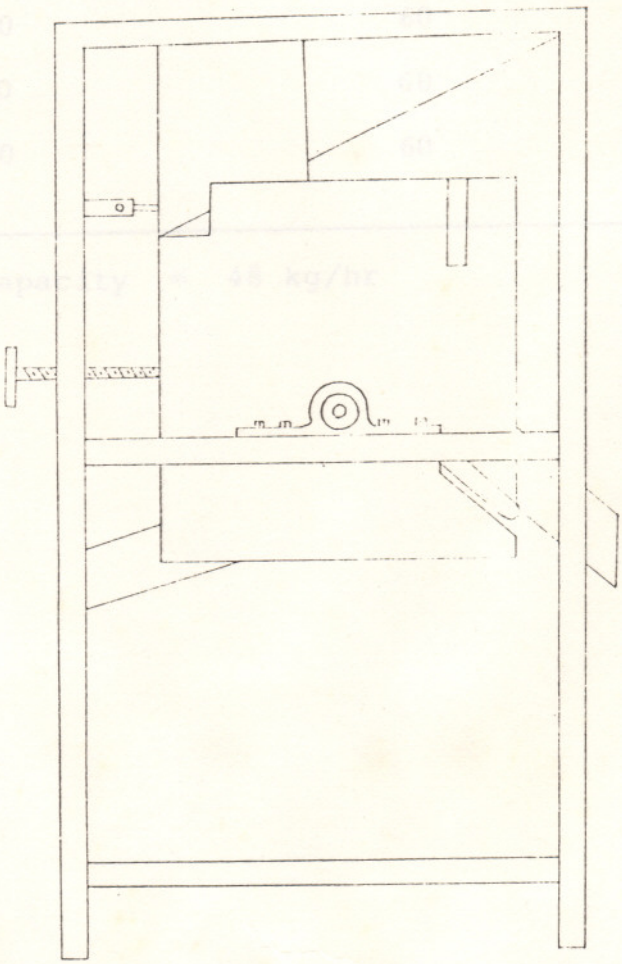
The average threshing efficiency was found to be 98.1 per cent. Higher values can be expected if nature pepper spikes are used for threshing.



ISOMETRIC VIEW OF THE MODIFIED KAU PEPPER THRESHER



PLAN OF THE MODIFIED KAU PEPPER THRESHER



ELEVATION OF THE MODIFIED KAU PEPPER THRESHER

Table 3. Determination of output capacity of modified pepper thresher

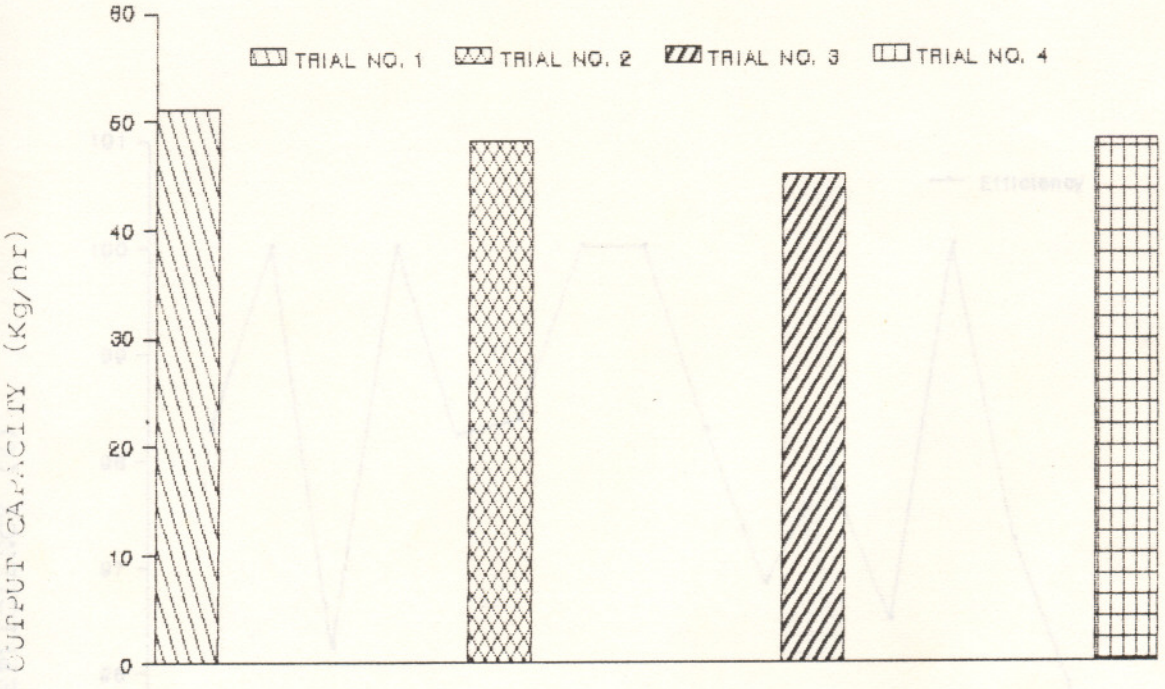
Sl. No.	Quantity of pepper (gm)	Time in seconds	Capacity kg/hr
1.	425	30	51
2.	800	60	48
3.	750	60	45
4.	800	60	48

Average capacity = 48 kg/hr

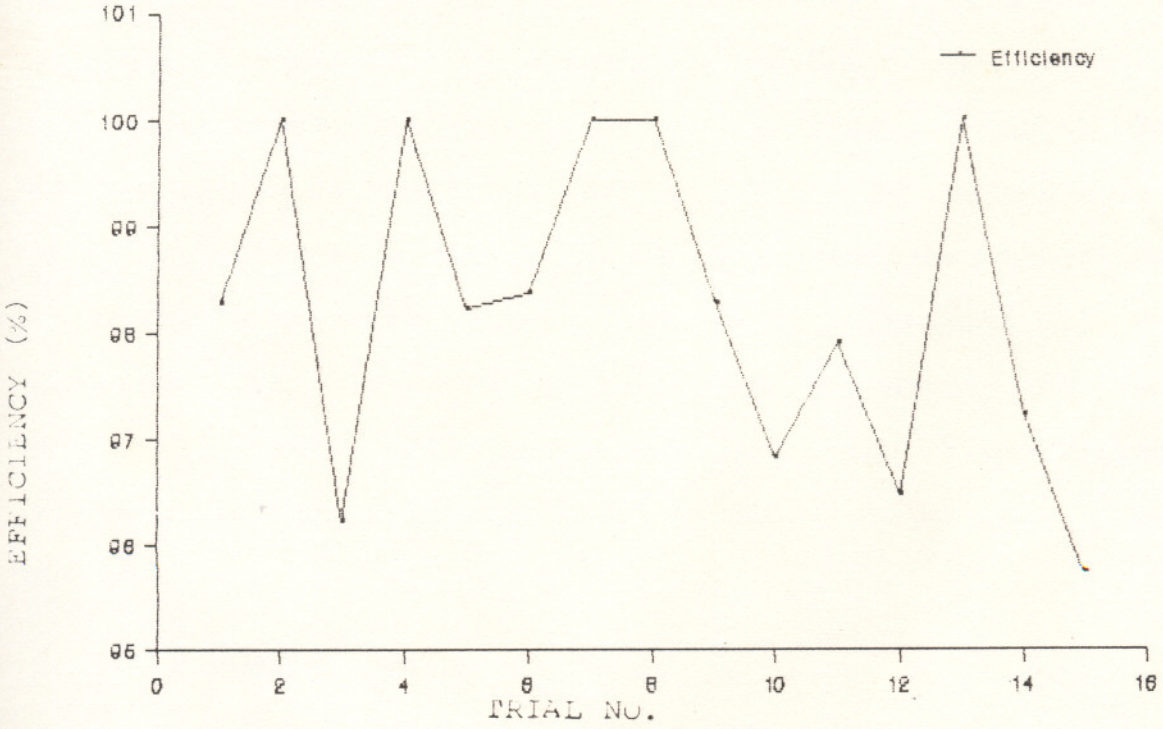
Table 4. Determination of threshing efficiency of the modified pepper thresher

Sl. No.	Number of berries before threshing	Number of berries after threshing	Efficiency %
1.	58	1	98.27
2.	64	-	100.00
3.	53	2	96.22
4.	49	-	100.00
5.	56	1	98.21
6.	61	1	98.36
7.	62	-	100.00
8.	56	-	100.00
9.	58	1	98.27
10.	63	2	96.82
11.	48	1	97.91
12.	57	2	96.49
13.	56	0	100.00
14.	36	1	97.22
15.	47	2	95.74

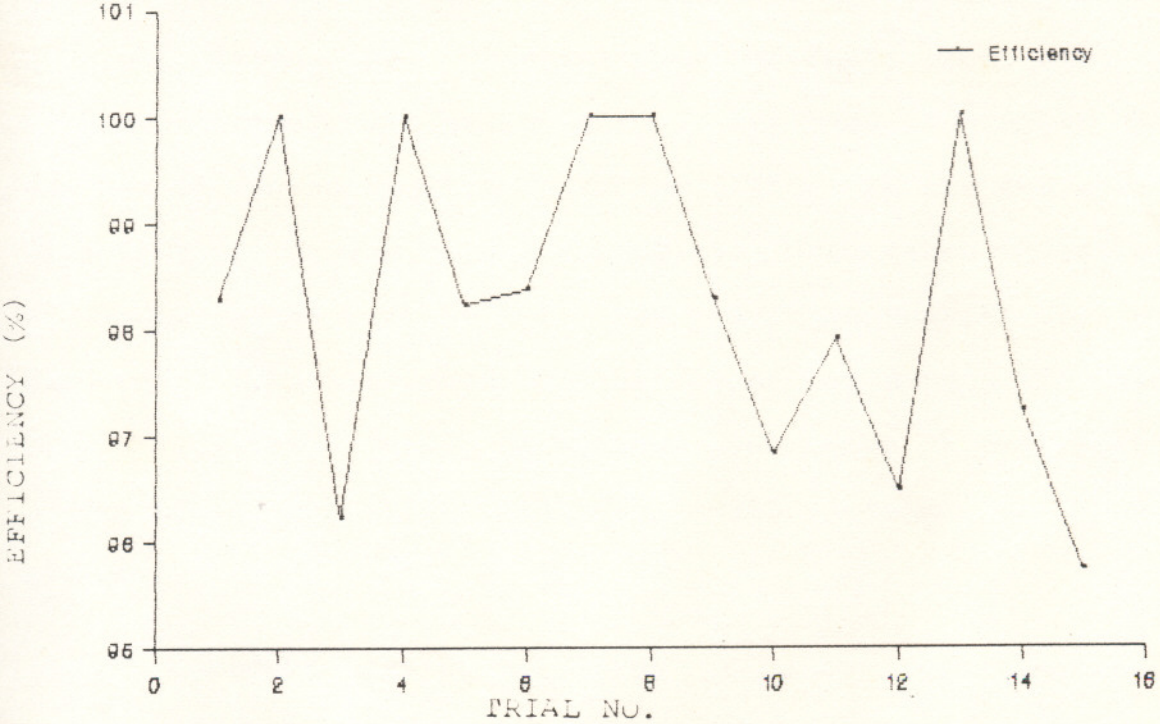
Average threshing efficiency = 98.1%



Out put capacity of the modified KAU pepper Thresher at different trials



Efficiency of the modified KAU Pepper Threshner at different trials.



Efficiency of the modified KAU Pepper Threshner at different trials.

SUMMARY

Improved agricultural implements and machinery are essential for increasing production, reducing the cost of production and maximising the efficiency of other costly inputs. In India the majority of farmers are in the small and marginal categories. So development of small, low cost and simple machinery are essential. In the case of pepper even now the threshing remains a problem. There is the possibility of losses of berries during threshing. Unthreshed pepper goes to waste along with spikes. The timely harvesting is also important. If harvested too earlier or harvested too late, threshing losses will be maximum and also field losses. Conventional threshing methods causes damages to pepper berries.

Moreover saving of time is also very important. Manual threshing requires more time. By using pepper thresher we may be able to handle large quantities in short time as compared to manual threshing. That is threshing can be improved by introducing threshers. The existing pepper thresher was a hand operated one. Moreover it had low capacity. Hence the existing black pepper thresher had to be modified for making it more efficient. The hand driven model

was modified as a power operated one. The shape of the hopper was completely changed. For making the threshing operation more efficient, thermocol was used. The shearing action required for threshing was achieved by allowing the pepper spikes to pass between the rotating drum and a stationary concave. Both the surfaces are made soft by adding rubber sheets. The drum cover is made of MS sheet of 14 gauge. The bottom grain receiver is made at an angle about 30° to the horizontal. The feeding chute is also made of MS sheet of 14 gauge. The rubber sheet covered concave is also made of the same material as that of the feeding chute. It is of the dimensions 850 mm x 200 mm. Eight millimetre diameter holes are made on it diagonally. The centre to centre distance between holes both in rows and column is 16 mm. The frame is made of MS angle of 25 mm x 25 mm x 2 mm size. The frame is having 682 mm length, 338 mm width and 1023 height.

During the initial testing it was observed that the performance of the thresher was satisfactory. The capacity of the modified unit is 48 kg/hr and the threshing efficiency is 98.1 per cent. The overall cost of the machine is approximately Rs.800/-.

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* Original not seen

APPENDIX-I

Specification of the pepper thresher

Type	:	Power/Manual operated
Power requirement	:	0.5 HP Electric motor/ 1 person
Length, mm	:	682
Width, mm	:	380
Height, mm	:	1023
Drum type	:	Rubber sheet coated for friction
Drum Dia, mm	:	333
Drum width, mm	:	185
Handling capacity q/hr	:	48 kg/hr
Developed at	:	K.C.A.E.T., Tavanur

APPENDIX-II

Economics

Economics of the thresher can be calculated considering its initial cost, operating cost and output in terms of the grain. Cost of operation can not be compared. However, with the following procedure, the economics can be calculated. The following appropriate assumptions can be made.

1. Salvage value of thresher (S) = 10% of initial cost
2. Life (L) = 5 years
3. Interest (I) = 12% per year of the initial year
4. Repair and maintenance = 4% of initial cost per year
5. Housing = 1% of initial cost per year

Let,

Fixed cost = Fc per year

C = initial cost

I = interest rate

Therefore,

A. Fixed cost (FC) per year

(i) Depreciation (Straight line method

$= (C-S)/L$

$= (C-0.1\ C)/5$

$= 0.9\ C/5$

$= 0.18\ C$

(ii) Interest = (C+S) I/2

= (C+0.1 C) 0.12/2

= 0.066 C

(iii) Repair and maintenance = 0.04 C

(iv) Housing = 0.01 C

Total FC = (i+ii+iii+iv)

= (0.18 + 0.066 +

0.04 + 0.01)

= 0.296 C

B. Operation cost per hour (DC)

(i) Labourcharges = No. of persons x existing labour rates per hours of operation

(ii) Power charges = Consumption in KW/h x rate per kwh

Total OC = i + ii

C. Unit cost of thresher per hour (Cu)

Cu = FC x OC / Number of hours used in year

D. Cost of threshing per tonne (Ct)

Ct = Cu/grain output in tonnes per hour

Sl. No.	Annual use (hrs)	Fc/hr (Rs.)	OC/hr (Rs.)	Cu/hr (Rs.)	Cost of threshing per tonne (Rs.)

Notes: The above calculated cost does not include the cost of prime-mover used for the operation of thresher.

MODIFICATION AND PERFORMANCE EVALUATION OF KAU PEPPER THRESHER

By
AMBUJAN. C. V.
RAVIKUMAR. C.

ABSTRACT OF THE PROJECT REPORT

Submitted in partial fulfilment of the
requirement for the degree

Bachelor of Technology
in
Agricultural Engineering

Faculty of Agricultural Engineering & Technology
Kerala Agricultural University

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1993

ABSTRACT

The KAU pepper thresher was designed and developed at Agricultural Research Station, Mannuthy in 1987 as a NARP project work. The existing KAU pepper thresher was a hand operated one and its hopper and some other parts were found to be less effective. Hence KAU pepper thresher was modified for making it more efficient. In this study an attempt was made to modify the above model for increasing its capacity and efficiency. The shape of the hopper was completely changed. The hand operated model was made more effective by replacing the bush bearings with ball bearings. Also provisions were made for converting the modified version to a power operated unit. The performance evaluation of the pepper thresher was conducted. The capacity of the machine was 48 kg/hr. The threshing efficiency was found to be 98.1 per cent. The cost of the machine was found to be Rs.800/-.