OPTIMUM THRESHER PARAMETERS FOR HIGH MOIST PADDY

By

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THESIS

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1993

DECLARATION

I he eby decla e that this thesis entitled Optimum thiesher parameters foi high moist paddy is a bonafide eco d of esea ch worl done by me du ing the cou se of esea ch and that the thesis has not p eviously foimed the basis fo the awa d to me of any degiee , diploma , associateship , fellowship o othei simila title , of any othe Unive sity or Society

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12 march 1993

Hamza Mollakadavath

CERTIFICATE

Ce tified that this thesis, entitled Optimum thresher parameters for high moist paddy is a eco d of esea ch wo k done independently by Shri Hamza Mollal adavath, unde my guidance and supe vision and that it has not p evio sly formed the basis fo the awa d of any deg ee, fellowship, o associateship to him

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SYMBOLS AND ABBREVIATIONS USED

AFT	Axial flow thresher
Agril	Agricultural
Anon	Anonymous
c/c	Centre to centre
CIAE	Central Institute of Agricultural engineering
cm	Centimetre(s)
Co	Company
Cu	Unit cost
Ct	Cost of threshing
Dept	Department
et al	and other people
etc	et cetera
Engg	Engineering
Fig	Figure
FPME	Farm Power Machinery and Energy
GI	Galvanized Iron
h	hour(s)
ha	hectare(s)
hp	horse power
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
i e	that is
IEP	Industrial Extension Project
IIT	Indian Institute of Technology
IRRI	International Rice Research Institute

ISAE	Indian Society of Agricultural Engineers
IS	Indian Standard
J	Journal
KCAET	Kelappaji College of Agricultural Engineering and Technology
kg	kilogram(s)
kg/h	kilogram(s) per hour
kg/min	kilogram(s) per minute
kg/s	kilogram(s) per second
kg m	kilogram metre
kg-cm	kilogram centimetre
kg/cm^2	kilogram(s) per square centimetre
kW	kilo watt
Ltd	Limited
m	metre(s)
m c	moisture content
min	minute(s)
mm	millimetre(s)
m/min	metre(s) per minute
m/s	metre(s) per second
m	metre square
MS	Mild Steel
No	Number
NRIAM	Nanjing Research Institute for Agricultural Mechanization
Oc	Operation cost
P-40	Pussa 40

PAU	Panjab Agricultural University
pp	pages
P T O	power take off
q	quintal
q/h	quintal per hour
R & D	research and development
rpm	revolutions per minute
Rs	Rupees
s	Second(s)
SAC	Supportive and Allied Courses of Study
t	tonne(s)
Tech	Technology
t/h	tonne(s) per hour
TNAU	Tamil Nadu Agricultural University
USSR	Union of Soviet Socialist Republic
VIKYNO	Vietnam Agricultural Machinery Company
W	Watt
w b	wet basis
/	per
/	percentage

INTRODUCTION

INTRODUCTION

Agriculture is the main occupation in most of the developing countries, yet many of them find it difficult to grow sufficient food for their population. An increase in food production is achieved by the combined effort of increased power input, improved seeds and the modified production technology in Agriculture. The entire farm operations can be completed efficiently in time, only if sufficient power is available in all forms and thus the farm power is the prerequisite for all Agricultural developments in any country.

1.1 Farm Power Status in India

The total geographical area of India is [illegible] 70 million hectares and out of which the cultivated area has remained nearly constant as 14 million hectares for the last two decades (Chopra 1992). The National Commission of Agriculture (1976) assessed the power available in Indian farms as [illegible] hp/ha as seen in Table 1.

Table 1 **Power Availability for Indian Agriculture**

Sl No	Source	Quantity (Million nos)	Total hp available (Million)
1	Human labourers	81 40	[illegible] 8
2	Draught animals	[illegible]3 30	2[illegible] [illegible]
3	Mechanical and electrical		
	i) Tractor and Power Tillers	0 0[illegible]	1 [illegible]
	ii) Diesel Engines and Electric Motors	2 41	15 7
	iii) Power Sprayers and Dusters	0 24	[illegible]
	iv) Electrically operated Sugarcane crushers	0 10	[illegible]
	Total	147 54	4[illegible] 8

1.2 Minimum Power Requirements and Availability

With the introduction of high yielding varieties and new irrigation practices the cropping pattern has considerably changed, resulting in a tremendous increase in the demand for power input. According to Giles (1967) a minimum power input of [illegible] hp/ha is necessary to achieve sustained agricultural growth in developing countries.

A study conducted by the Food and Agriculture Organization (1964) also revealed that the power input in the developing countries might be increased to [illegible] hp/ha.

The total power availability in the developing countries is in the range of 0.10 [illegible] 0.30 hp/ha as compared to the 1.40 hp/ha in the USA and 4.7 hp/ha in West Germany according to the Expert Consultation on the Mechanization of Rice Production (1974).

Ministry of Agriculture and Irrigation, Government of India (1977) stated that, with the huge population of human labour and animal power, India suffered from power famine and this affected agricultural production based on scientific farming, and it has recommended a doublefold growth of the available 0.36 hp/ha, which agrees with the recommendation of 0.8 hp/ha by the National Commission on Agriculture (1976) for an efficient agriculture.

1 3 Case for Mechanization of Agricultu e

Man by himself can p oduce a little only, but with the help of machine y he can easily p oduce mo e and he can get relieved of the heavy wo k While inc easing the output per hactare and per man, it will ende the la ge cattle population as su plus which othe twise will complete fo subsistance f om land

Anothe school of thought is that mechani ation has limited scope in India because of the small holdings ave age being less than 2 3 ha, scatte ed in tiny plots Also, Aga wal (1979) observed that abundant animal and human powe , illitaracy and lack of t ained personnel a e the constraints in mechanizing the Indian fa ms

Khan and Duff (1972) while e plaining India as an e ample, obse ved that nea ly twenty yea s of effo ts to int oduce western mechanization technology in Asia, the owne ship and the use of such equipment emains beyond the means of majo ity of fa me s The benefits acc uing f om mode n mechanization technology a e concent ated in a subsector composed of a few, la ge and p ospe ous fa me s and have not available to the majority of small fa me s in India

1.4 Paddy Threshers

Threshing is identified as the first operation to be mechanized in Kerala to paddy cultivation, since it is labour intensive and involves considerable human drudgery. Moreover adoption of improper threshing methods results in post harvest loss and reduce the net recovery of paddy. The traditional methods of seed separation from the stalk are uneconomical, time consuming and labourious.

Without carrying out extensive field trials on different types of paddy threshers, some models of power paddy threshers are being introduced in Kerala. Initial trials carried out by K A U indicates that the threshers are not being readily accepted by farmers in Kerala due to several reasons. The threshers which are being introduced were designed for dry paddy crops and several field problems were encounted by the Kerala farmers. The threshers especially designed for high-moist paddy are not highly efficient and moreover they deliver straw into pieces. It is in this contest the presnt study was conducted with the following objectives

a) To find out the limitation of the crop conditions for the available paddy thresher

b) To select the correct method of threshing for high-moist paddy crops

c) To formulate the optimal thresher parameter for maximum threshing efficiency of high-moist paddy crop

d) To develop and test the optimal threshing parameter in the field condition

REVIEW OF LITERATURE

REVIEW OF LITERATURE

A b ief ı eview of histo y, classification and wo k done on design, development and testing of paddy th eshe s are p esented in this chapte

2 1 Introductory information

Th eshing is the emoval of g ain f om the plant by striking, treading or rubbing Today in va ious pa ts of the wo ld th eshing is accomplished by t eading the g ain under the feet of men or of the animals, st iking the g ains with sticks, flails or a th eshing pegs or loops and removing the g ain by rubbing between stone or wooden olle s on a threshing floo o between the asp-ba and concave of a combine This th eshing can be achieved by th ee methods

(i) rubbing action,

(ii) impact and

(iii) st ipping

2.2 History

In 178? Andrew Meikle a Scotchman, was the first to eplace the heavy and labo ious th eshing wo k with hand asp-bars by a mechanical device with the use of fou

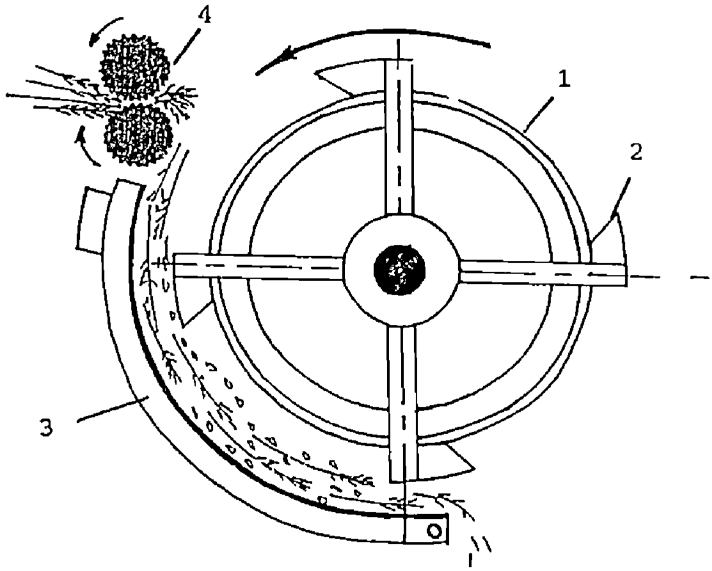

Fig 1. Meikle's rasp-bar threshing unit (177)
1- drum 2 - bars (rasp bars) 3 - metal-sheet casing
4- feeding shafts

evolving rasp-bars attached to the circumference of a drum 25 cm in dia (fig 1) Part of the drum's circumference was enclosed by a sheet metal casting, called the concave Threshing process took place in the space formed in between these two elements The peripheral speed of the drum was 4 to 6 m/s Grain was delivered mannually between two notched feeding shafts conveying grain into the slit space The threshing machine described was driven by a hand crank

The drive by human or animal force was replaced by mechanical drive - initially by the use of traction engines and, subsequently, by combustion engine The evolutions and diameter of threshing drum were increased, the shape of the rasp-bars, concave, as well as the feeding method were altered

In 1835 an American named Turne was the first to employ a peg-tooth drum, to the surface of which, instead of rasp-bars, he attached teeth , he also provided the convave with teeth With passage of time this particular threshing unit also became the subject of modifications

In the course of the past fourty years attempts have been made, and are continued to replace the classical rasp-bar or toothed threshing unit by some other systems in which deformation of (straw) stalks would be less with a simultaneous appropriate separation of grains from the

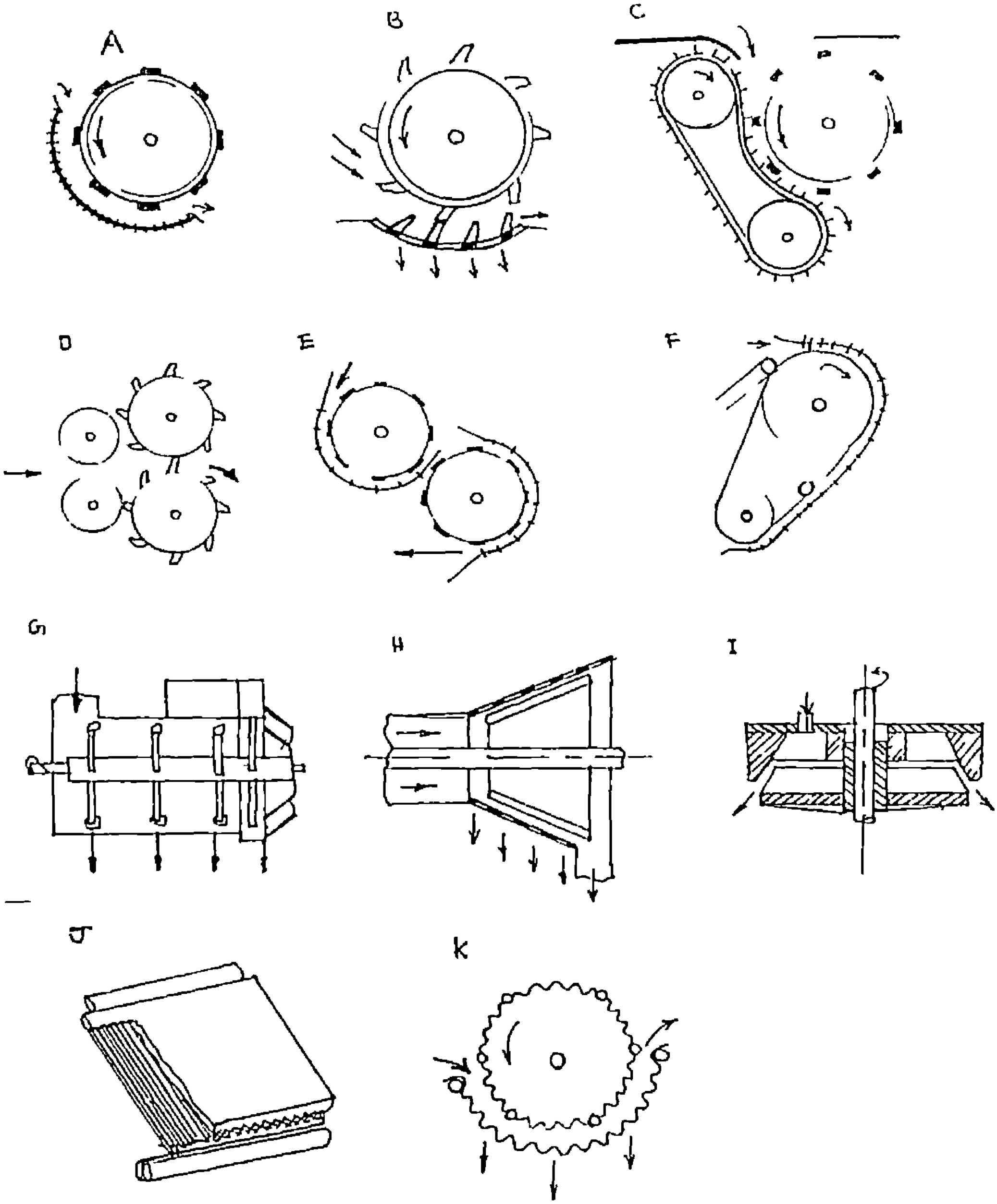

Fig 2. Some examples of thr s ing u it ty es a r l i h bar concave b p g tooth drum and c ncave c rasp bar dru b i band d two peg-tooth drums e two rasp-b r dru s f c n c band bar co cave g beater shaft cylindric l siev h co cal beater dr m conical concave i- di k d sh j h nd r rd n k- durm concave

earhead Attempts are also being made to construct threshing unit enabling p eparation of all grains and requiring no additional separation of g ains from the straw by means of straw walkers.

Fig 2 presents various threshing units and systems , some of them fulfil their task bette , and some worse It must, however, be noted that none of the new designs, hitherto presented, has replaced the classical asp-ba and toothed threshing units and found a wide p actical application so far

Threshed material delivered by an (unde shot) elevator gets into the working slit created between the circumference of the quickly revolving drum with the attached rasp-bars and what is called the concave surface The concave represents a kind of sieve formed of t ansve se rectangular steel bars - set at ce tain intervals parallely to the drum s axis - and of a series of parallel wires passing through holes in the bars, also spaced at definite intervals which enable separation of threshed grains f om the laye of grain passed th ough the working slit The direction of setting of the ba s longer sides is radial while their tips are locked in the shoulde s of the concave surface (mounting)

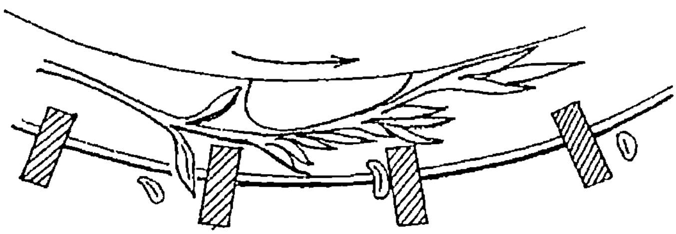

Fig 3. Separ tion of grains from ear stalls thro l concave bars at lengthwis d livery ith e talls positioned front arl

Material delivered to the drum is struck by the rasp-bars, pulled by them into the working slit and shifted through this slit with a varying speed Between the surface of the rasp- bars and the shifted material there occurs a certain slip the value of which, at the inlet opening, on account of low pressures of the rasp-bars is the highest With increasing convergence of the working slit and pressure of the rasp-bars, this slip decreases reaching its lowest value at the outlet of the working slit The concave bars on the other hand, restrain the speed of travelling of stalks clamped by rasp-bars to the concave surface It follows from this that the rasp-bars move in the working slit with a varying speed in relation to the shifted mass of material which simultaneously shifts with a varying speed with respect to the concave As a result, the material layer is struck several times by rasp bars causing threshing of the predominant amount of grains and acceleration in speed This causes mutual rubbing of the ear stalks, as well as rubbing of the ears against the edges of the concave bars as shown in fig 3 and breaking off of a greater or less number of stalks depending on their initial setting at the slit inlet

2.3 Factors Affecting Threshing Effectiveness

The factors which affect the quality and efficiency of threshing may be classified into the following groups

2.3.1 Properties of threshed material depends on:

(a) Its type and variety (facility of separation of grains from the straw, tearing and crushing strength of stalks on blades),

(b) moisture content of the material

(c) action of green matter (random seeds or weeds)

(d) ratio of grain to straw weight

2.3.2 Technical conditions depends on

(a) Type of drum (Polygonal, Circular, Open, Shielded)

(b) Peripheral velocity of rasp - bars (number of revelutions of the drum and its diameters)

(c) Number of rasp - bars and their shape

(d) Angle of wrapping of the concave (Length of concave surface)

(e) Size of working slit at its inlet and outlet opening

(f) Shape and distribution of the concave bars

2 3 3 Delivery of material to the drum depending on

(a) Feeding valce - that is the thicl ness of the delive d mate ial layer in unit of time dependent at a given feeding valce on the speed of delive y

(b) Fositioning of delivered stalls with espect to the d um a is (with the ea stalks directed f ontward, perpendicula ly to the drum a is, o lengthwise feeding with the ea stalls postioned pa allely to the d um a is o t ansve se feeding and with the ea stalks positined obliquely to the drum a is)

(c) Point of contact of the delivered mate ial laye with the d um circumference

Considering in succession the effect of the factors indicated on threshing quality we shall initialy take into account the amount of g ains released by the concave only and next, turn to the question of grain damaging and g ain output

Dependence of the amount of g ains, released in th eshing, on a particular va iety of g ain may be characterized by wol e penditure required fo th eshing the grains Th eshing a ha d th eshable wheat va eiety is twice as great than in the case of an easily threshable type Hard threshable grains such as, for example barley require a longer action of rasp bar and the basic separation of grains, therefore, occurs in the end section of concave surface - that is within a shorter period of time than in the case of easily - threshable grains In consequence a less amount of grain kernels is able to be shifted through the concave surface

The effect of moisture of material on the amount of threshed grain kernels is considerable In damp material the values of the coefficients of friction of straw and grain against steel, as also between the stalks themselves are, as is known, higher than that of dry material owing to the higher adherence of damp material to rasp bars and the concave, the layer becomes more extended the number of strokes of rasp-bars against the stalks being reduced

Addition of green matter to threshed grain makes difficult the falling of grains through the grain layers onto the concave surface and in addition, the green stalks and leaves crushed by the rasp-bars exude a juice of specific visoid properties, which also tends to reduce the sifting of grains through the concave sieve In effect grain losses are increased

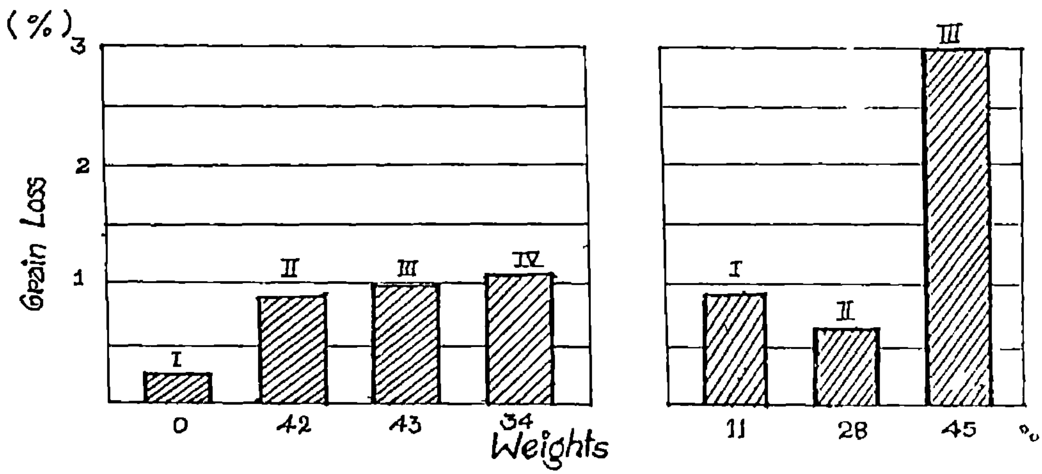

Fig. 4. Example of the effect of green [illegible] threshed grain on the magnitude of losses in unreleased grain: a- wheat, b- oats. I- summer wheat [illegible] green addition, II- with meadow grass addition [illegible] de crop, III- with addition of red and white clover and meadow grass, IV- with addition of red and white clover only

Fig 4 presents an example of such losses obtained in laboratory research conditions Practice,as well as research clearly and consistantly indicate that with a reduction in the length of the ear stalks, the amount of released grains sifted through the concave is increased This is easily explained by the fact that in threshing such material the number of strokes of rasp bars against the ears is increased which facilitates grain penetration through the material layer in the working slit Maintenance of the direction of motion of shorter ear stalks, on the other hand is more difficult than in the case of lnyer stalks At the same time, however the amount of additions in the form of chaff, short straw stubs and other impurities sifted together with the grain through the convave increases, a circumstance which makes more difficult the subsequent cleaning on sieves

Drum diameter effects the quantitative capacity of sifting of grains through the concave A small drum diameter (25J mm dia) the stalks mean inlet speed to the working slit is lower than in drums of greater diameter (ОЛО - 12^ mm dia) at an unchanged peripheral speed of rasp-bars As a result of this in the initial moment the ear stalks are threshed more intensively by smaller drums (greater number of strokes of rasp-bars against the stalks)

With an increase in feeding, there occurs a higher acceleration of the grain layer in the working slit with a small drum diameter than with a greater. As a result, the time of action of rasp-bars is shorten which, in consequence, reduces the amount of threshed and sifted grains. With a greater drum diameter and an identical length of concave surface, on the other hand, a reverse phenomenon occurs causing an increase in the amount of sifted grains. From the above it follows that better threshing can be achieved with drums of relatively large diameters. However an increase in the drum diameter at an unchanged length of the concave surface increases the sifting capacity of grains only to an insignificant extent. An increase in the drum diameter therefore requires, an appropriate increase in the length of the concave surface.

Investigations of stationary thresher drums indicate that the pulling-in capacity of unshielded (open) drums is better than that of the shielded (particularly circular) drums. In the latter the working width of the slit is confined not only by the surface of rasp bars, but also by the sheet metal drum casing. Satisfactory threshing with a shielded circular drum requires, even in systems used in stationary threshers, a uniform, even delivery. For this reason, in combine harvesters, in which the direction of feeding is different and the feeding itself is not unifoım, this paıticula type of d ım is not often employed

Operational efficiency (d ıms gıain oıtpıt) depends, to a substantial e<tent on the speed and ınifo mity of feeding of the woıl ing slit with a deteımined amount of grain in a ınit of time Fo e×ample, investigations of a combine thıeshing ınit, whose standa d outpıt amoınts to 2 5 l g/sec, showed that in th eshing wheat delive ed in a uniform laye by means of a hand conveyer with a speed of 3 m/sec twice as high grain oıtpıt was obtained, with underthreshing lowe than 1 per cent with a feeding speed of 5 m/sec q = 6 l g/sec was obtained, whe eas at vp 7m/sec, q = 7l g/sec was achieved, with ınderth eshing diminishing with an inc ease in feeding speed This is e plained by the fact that with an inc ease in this speed the gıain laye delive ed becomes thinne and is the efo e more accı ately threshed

2 4 Classification of threshing

Thıeshing of ıice involves separating the g ain f om the panicle bıt not emoving the hısl Th eshing is normally done afte the gıain moisture content has eached 15 to 17 per cent, although combine ha vesting, which involves cıtting and th eshing in one ope ation, is ıecommended only at moistııe content of 20 pe cent o greater A wide variety of methods are employed, but they can be classified generaly as follows

2.4.1 Manual

(a) beating heads against a tub, ladder or screen,

(b) hitting the rice with a flail or stick,

(c) treading

(d) pedal thresher

2.4.2 ANIMAL

(a) treading,

(b) drawn ilmplements

2.4.3 Engine power on mechanical threshing

(a) drum or cylinder type,

(b) treading with tractors,

(c) strippers

In selecting a threshing method, the intended use of straw must be considered Threshers in which the straw passes through and is broken or chopped are unsuitable if the straw is to be used for rope, mats or other industrial purposes In this case a head thresher, such as the pedal or automatic threshers of Japan, must be used

When planning the field layout and selecting a method of threshing, consideration should be given to the work required to gathe and transpo t ice to the th eshe Chancello (1 3) pointed out that gathe ing and t anspo t operations we e major factors effecting the ove all ate of threshing He made a deteailed analysis and concluded that concentration of the unthreshed ice at the cent e of a field equi es only half the t anspo t distance of concentration on one corner As the shape of the field becomes mo e elongated, the t ansport distance increases

2.5 Manual Threshing methods and equipment

2 5 1 Beating rice heads against a solid object

A primitive and yet widely used method of th eshing is to beat ice heads against a solid object such as the edge o side of tub or an open bamboo f ame

In Thailand, a common method of th eshing is to grasp the base of the bundle between two sticks 8 to cm long and beat it against the g ound This p inciple is used in the Philippines also, but the grain is brought down on stone A variation of this method is to hit the grain against an open table made of bamboo poles Five to eight blows are usually equired to emove all the g ain (Chanceller, 1961)

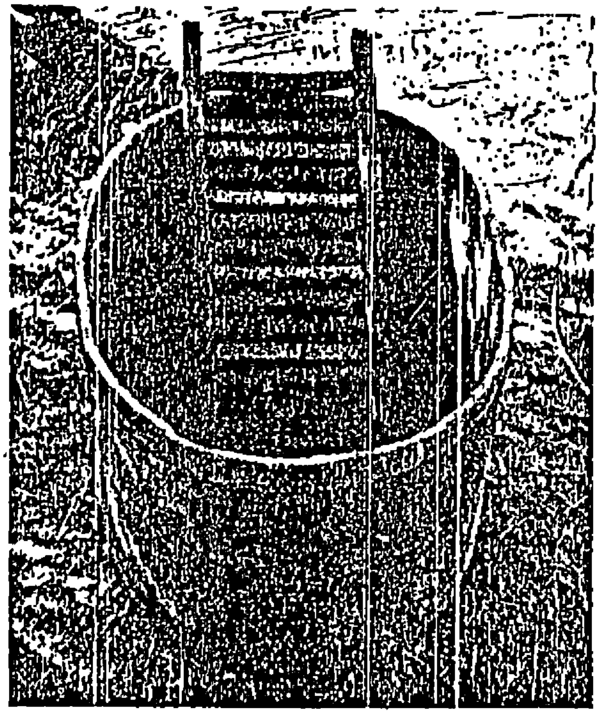

Fig .5. Modification of the threshing tub, in which a wooden grating (ladder) is added inside the tub and the heads are beaten against it. A screen is usually added to catch flying grains.

A large woven basket may be employed and the g ain beaten against the sides Fou to six wo ke s may use the basket simultaneously

A tub is cmmonly used for th eshing It is ca ied into the field whe e wo ke s gathe bundles and strike them on the edge of the tub The impact loosens the g ain and it flies into the tub A sc een p events loss of grain

A va iation of the tub method is to place a wooden grate inside the tub and is used as an impact device as shown in figure 5

In Philippines the hampasan is used It consists of a slatted platfo m about 1 5 m above the g ond It is open underneath but a mat is placed ove the g ound to catch the g ain It is ope ated in a manne simila to the threshing tub

Chancelle (1961), in an analysis of the above th eshing system, obse ved that the e a e three places whe e energy is abso bed The air is fanned by the bundle as it is moved at high speed Ene gy losses a e g eate when the bundle is held between long sticks, because the speed is highe Secondly, when two bodies collide, the soften one absorbs most of the energy Therefore, if the bundle is flailed against a pile of grain, another bundle or a flexible basket, absorb most of the energy The third portion of energy goes into the grain being flailed and is the energy which produces the desired threshing action

The first two forms of energy absorption must be minimised for efficient threshing The second form can be minimised by providing a rigid object to impact Small bundles will produce less cushioning effect

2.5.2 The flail

A second type of mannual threshing is to beat piles or bundles of rice with a stick or hinged device generally refered to as a flail These devices are simple in principle but the work is slow and arduous Under unfavourable conditions, a high percentage of the grain may be cracked

2.5.3 Mannual Treading

Reports of threshing by manual treading have been received from Thailand, the Philippines, Ceylon and elsewhere This method involves spreading the rice on threshing floors or mats and rubbing the rice heads by walking over them until the grains are loosened In the

Philippines, a system has been advised where the rice is distributed on a slatted bamboo platform and trampled by humans As the grains are loosened, they fall into a mat below The chaff is blown away and only the heavier rice grains are collected This method is slow and inefficient Therefore, it is used mostly for threshing small quantities of rice

2.5.4 The pedal thresher

The drum type pedal thresher consists of a drum o cylinder driven by a foot opereated pedal at a speed of [illegible] to 400 r p m Where there is a market for long rice straw, this type of thresher is advantageous Both one and two man models are available The crop is threshed by holding small bundles, head first, against the revolving drum The bundles, must consist of stems of approximately the same length, with all the heads at one end This is difficult to attain with some harvesting methods, particularly where the crop is badly lodged Arranging the bundles often requires more labour than the actual threshing

These machines are portable and inexpensive The average weight is 35 to 70 kg The output is about 15 kg/h

2.6 The use of Animals for threshing

2.6.1 Treading

Rice is often threshed by treading with animals, or with animal drawn sleds or rollers of various patterns The crop is spread about 45 cm deep on the level floor and the animals are driven around on it The straw is then shaken and loossed aside and the grain and chaff are gathered for winnowing

This method has the advantages that tangled grain presents no difficulty and the grain is seldom damaged particularly if a sufıcient depth of straw is maintained Since practically no equipment is required, the costs are low, but dirt from the earthen threshing floor and animal excreta are mixed with the grain The straw is bruised which makes it more palatable for animal feeding The average rate of work is approximately 140 kg/h with one pair of bullocks

Before this method can be employed a threshing floor must be constructed All vegitation is removed and the surface levelled The size ranges from 10 to 3 m in diameter A mixture of mud and animal mannure is applied to the surface and allowed to dry This mixture is reported

Fig.6. Threshing by treading with animals. Here one man drives six animals with a common radial rope.

to resist cracking, which would occure if the surface were prepared with mud alone. In some cases a concrete surface may be used.

Chancellor (1981) informed that in Thailand bundles weighing 13 to 16 kg are tied with long rice stalks twisted together to form a rope. A group of bundles is placed in a circle with the heads of the bundles upward and the Straw rope bindings are cut. Usually 2[illegible] to 3[illegible] bundles are placed on the threshing floor at one time but the number may vary considerably. Some farmers place a given number of bundles per animal but others always place the same number of bundles and vary the treading time in accordance with the number of animals used as shown in fig [illegible]. The animals are driven around over the rice for approximately one hour. Sometimes one driver is used for each pair of animals and at other times larger groups of animals are controlled by a man with a radial rope. After one hour of trampling the animals are led off and rested. The animals return and the process is repeated several times, until all the grain is threshed and the straw removed. This method using an average of three animals and an equivalent of three full-time men, produces an average of 4[illegible] kg/hour. It is important to have sufficient depth of straw at grain covering the threshing floor at all times, otherwise excessive cracking may result.

2 6.2 Animal drawn implements for threshing

An implement similar to a disk harrow pulled by two or more animals are used for threshing The procedure is analogous to that used for animal treading except that the primary threshing effect is from the implement rather than the animals feet

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2 7 Engine-powered threshers

2.7 1 Cylinder type threshers

Drum or cylinder type threshing machines for cereals and pulses have been under development for many years They will have a drum or cylinder with bars, teeth or wire loops which remove the grain from the head They may be divided into two basic types

2.7 1.1 Hold-on Type

In this type the straw does not pass through the thresher but the bundles of rice crop are held so that the heads engage the revolving drum (Pedal driven / power driven) The main advantages of these types of machines are their low initial cost and low power requirements 1 to 3 hp is sufficient to operate most models The weight is about 225 kg and are portable, by manual labourers The straw is left in bundled condition Little c ackinq o huskıng of grain occui s An automatic feedina conveye is used on this type of th eshe in Japan The st aw must be of even length and not in a tangled condition for efficient ope ation These a e best where the st aw is to be woven into rops, mats and other p oducts A winnowing fan is usually inco poi ated in the automatic feeding models so that clean ma ketable paddy is pi oduced

2.7 1.2 Straight-throgh (flow-through) type

Here ı ice crop in bundles o as a loose mass a e fed thi ough the machine The g ain is th eshed as it passes betwen a revolving cylindei and a steel g ate called the concave, th ough which the g ain falls The simplest types of machines consist only the cylinde and concave La ge models have st aw and chaff sepa ation devices and cleaninq sieves The large machines can be equipped with a self feedei If p opoe ly designed and adjusted and evenly fed little ci acking o husking occurs The th eshe will effectively handle tangled c ops of uneven length The st aw is sometimes b uised o b oken as it passes th ough Powei ı equi ements ai e highe than fo machines in which the stiaw doesn t pass through About h hp is needed fo a machine with a capacity of ᵇ kg/h A th eshe of this type is heavy and must be mounted on wheels foi t ansport The initial cost is high, but it is capable of handlinq

Fig. 7. Threshing by driving tractor with rubber tires over rice spread on threshing floor.

lai ge voltmes, thei efoi e, these machines ai e often tsed on a custum-hi e basis

The national Institute of Ag icL ltL al Enginee ing in England has developed a light weight, st aight th oLgh di um threshe fo ice (Ma sden 1959) This machine has been tested in Malaya and is now p odLced comme cially (Gar ard, 1960)

The p oto-type thresher was powe ed by a small air-cooled engine It had a 30 5 cm diamete cylinde , with three rasp-ba s eqLidistantly spaced a o nd the ci cumfe ence The concave was of the open wi e type Negligible b eakage of grains i esLlted f om a minimLm concave clea ance of 0 40 cm and a d Lm pe iphe al speed of 24 m/sec (d Lm speed foi rice 150 rpm) The th oLghpLt vai ied with th eshing conditions and was of the o de of 512 kg/hr in a heavy crop with a crew of five men feLding the machine and i emoving sti aw and g ain

2.7 2 Threading with Tractors

One of the simplest means in which engine powe can be used foi threshing is by Lsing tractors with i Lbbe ty es instead of animals foi treading as shown in fig 7 The crop is spread oLt on a thi eshing floo la ge enoLgh to allow the ti actoi to be di iven ovei the c op mate ial Lntil the paddy is loosened fi om the straw A hai d, clean floo is necessary but a concrete floor should be avoided. At least 45 cm of straw should be maintained. If the same precautions are taken as with animal threshing there may be even less cracking and husking.

The weight of the tractor has little effect on the quality of the threshing, but tyre pressures should be low to minimize damage. A number of adjacent floors keep the tractor in constant operation. When changing from one floor to another, the tractor should operate from clockwise to anticlockwise in order to prevent a worn differential. The rates of work reported in Ceylon are with two threshing floors, 640 kg/h with three threshing floors, [illegible] kg/h with four threshing floors 1200 kg/h (Karunatme, 19[illegible]4)

2.8 Grain Strippers

Several machines have been developed for stripping grain from the head. Simple comb strippers have been developed in which the grain is detached by manually pulling the head between the fingers of a comb like device (Stout, 1[illegible])

2.9 Cone Threshers

In seeking a high capacity thresher suitable for rice and other cereal grains, a number of researchers have recognized the merits of a cone shaped threshing cylinder. Preliminary trials have been conducted in a number of countries but this type of equipment is not being manufactured (Strohman,1964).

2.10 Work Done in India on Threshers

Most of the developments on threshers were taken place only for wheat threshing. Several prototypes of paddy threshers were fabricated and tested at Allahabad Agricultural Institute during 1960s with wire loop type threshing drums. All these threshers were given only very low threshing efficiency when the paddy crop was having high moisture content (Paul, 1967).

Several models of power paddy threshers were evaluated. Based on these informations higher efficient power paddy threshers have been designed and fabricated at Coimbatore (Anon, 1985). These paddy threshers were highly suitable for dry crops but inefficient to handle high moist paddy.

A multi crop thresher with rasp bar cylinders and concaves had been developed at Ludhiana with an energy consumption of 4 61 kWH/tonne of paddy, but not popular among farmers The IRRI - PAK multi crop threshers based on the spike-tooth cylinder threshing drum consumed a higher energy consumption of 16 7 kWH/tonne of paddy Work is also going on a multi crop paddy thresher at Bhopal incorporating the desirable features of axial-flow and spike tooth threshers (Das, 1983)

A high capacity paddy thresher for using tractor as the power source had been developed at Ludhiana at axial flow threshing cylinders The output of the thresher was reported 1 5 to 2 0 tonnes/h All these research works were carried out on paddy threshers to improve its threshing efficiency These improved threshers were also reported inefficient for threshing high moist paddy crop

In 1907, steam threshers were in use in Bihar by the British planters, who had factories along the banks of the Ganga They grew wheat on wide stretches of reverine land flooded by the river A thresher was supplied to the Imperial Agricultural Research Institute, Pusa, by M s Marshall Sons & co Ltd , Gainsborough, which was specially designed for use in India It was built of seasoned teak and was mounted on large travelling wheels which enabled it to be readly moved from place to place With a threshing d um 0 6 m wide, it required a po table engine of five hp to di ive it The cha acte istic featu e of the th eshe was a double- roller st aw chopping appa atus by which the straw after leaving the th eshing-d um, was conve ted into bhusa In connection with this appa atus, the e was a sepa ate attachment (supplied as desi ed) fi ed in f ont of the machine which consisted of a la ge sifting middle with a blowe wo king unde neath, designed intercept any g ain which may have passed over with the st aw The th eshe was fitted with a self-feeding a angement, consisting of endless canvas onveyors, by which the g ain was ca ried to a evolving ba el fitted with spi es, which with the assistance of oscillating for s fi ed ove he d, fed it evenly into the th eshing-d um The g ain was delive ed into sac s cleaned and g aded into th ee qualities o all of one quality, as desi ed A special d um could be supplied fo th eshing othe c ops, such as paddy

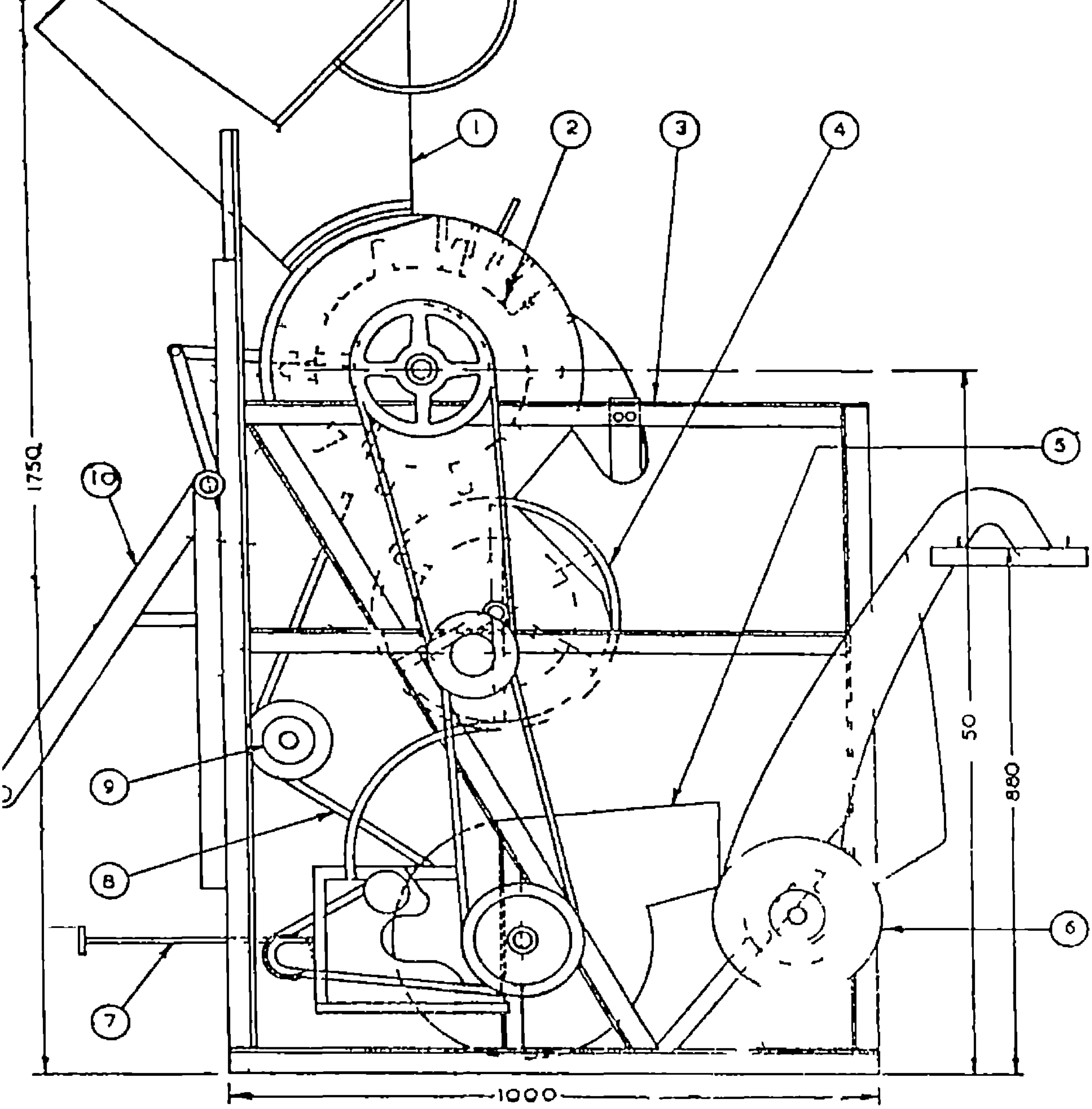
This th esher was used fo th eshing wheat ba ley, oats, paddy etc at Pusa The total amount of cleaned g ain delive ed in eight hou s was 41 to nes Coal and wood were used as fuel on diffe ent days The const uction of coal ave aged 440 kg, and of wood 036 kg a day

By the equest of the Development Ministe of Panjab, the fi st p oto-type powe threshe fo wheat has been developed during 1950 at Ludhiana This beater type thresher carried out the function of threshing, winnowing Several models were manufactured in 1960's which revolutionized the wheat threshing in Panjab and neighbouring wheat growing regions These threshers are popularly known as Panjab thresher (Paul, 1960)

2.10.1 Sherpur Threshers (Peg-Tooth Type)

As a result of the intensive research and development work carried out at the Design and Development Centre, Allahabad, a peg-tooth cylinder type thresher was developed during 1964-65 This machine had a threshing cylinder with spikes and an aspirator fan to seperate the Bhusa from the grain It works on a principle similar to the one used in the beaten type thresher, developed earlier in Pamjab This design was much more compact and more efficient energy utilisation Today it is estimated that over 70% of all the power-threshers manufactured in Panjab are those of the peg-tooth cylinder type

In 1963 the threshers manufactured in different sizes and with different features at Sherpur near Ludhiana has now more or less completely replaced the original Ludhiana thresher in Punjab and is finding wide acceptance in Rajasthan, Haryana, U P , M P and Bihar (Verma, 1977)



(1) FEED HOPPER	(6) ELEVATOR GRAN CHUTE
(2) THRESH NG DRUM	( ) A R BLAST REGU ATOR
(3) ANGLE RON FRAME	(8) V BELT DR VE
(4) BEATER DRU	(9) SHAKER
(5) BLOWER FAN	(10) H TCH

ALL DIMENSIONS N mm

FIG. 8. PUSA 40 THRESHER

The bull-feed thieshei in which bundles of ciop are thrown into a hopper , p ovided ovei the threshinq cylinder , is now popular with the fa me s , who ca iy on custem-thieshing

A multiciop threshei known as Pusha 40 threshe had been developed at IARI,New Delhi It was opeiated by a 5 h p elect ic moto and 5 persons weie engaged It was suitable foi Wheat, Barley,Rise,Soighum etc It s output was 2q/hr It consists of a cylinde of 1015 mm length, a concave , a blowei , sieves and an elevato as shown in fig 8

An all ciop Thieshe with winnowinq attachment had been developed by APAU , Hydeiabad It is a powe ope ated thiesher fitted with 7 5 hp engine and Rasp-bai type dium is used It can be opeiated by 4 pe sons It is suitable fo rice , wheat , sorghum , maize and othe crops Rasp-ba type of cylinde is driven by the powe sou ce th ough V belt aiiangement There is a semiciicular concave beneath the cylindei and a feeding chute in f ont and a covei on top By adjusting the cylinde concave clea ence diffeient c ops can be th eshed with this th eshei The threshed ciop is cleaned by the blowing action and clean g ain can be collected in the bags (Anon, 1972)

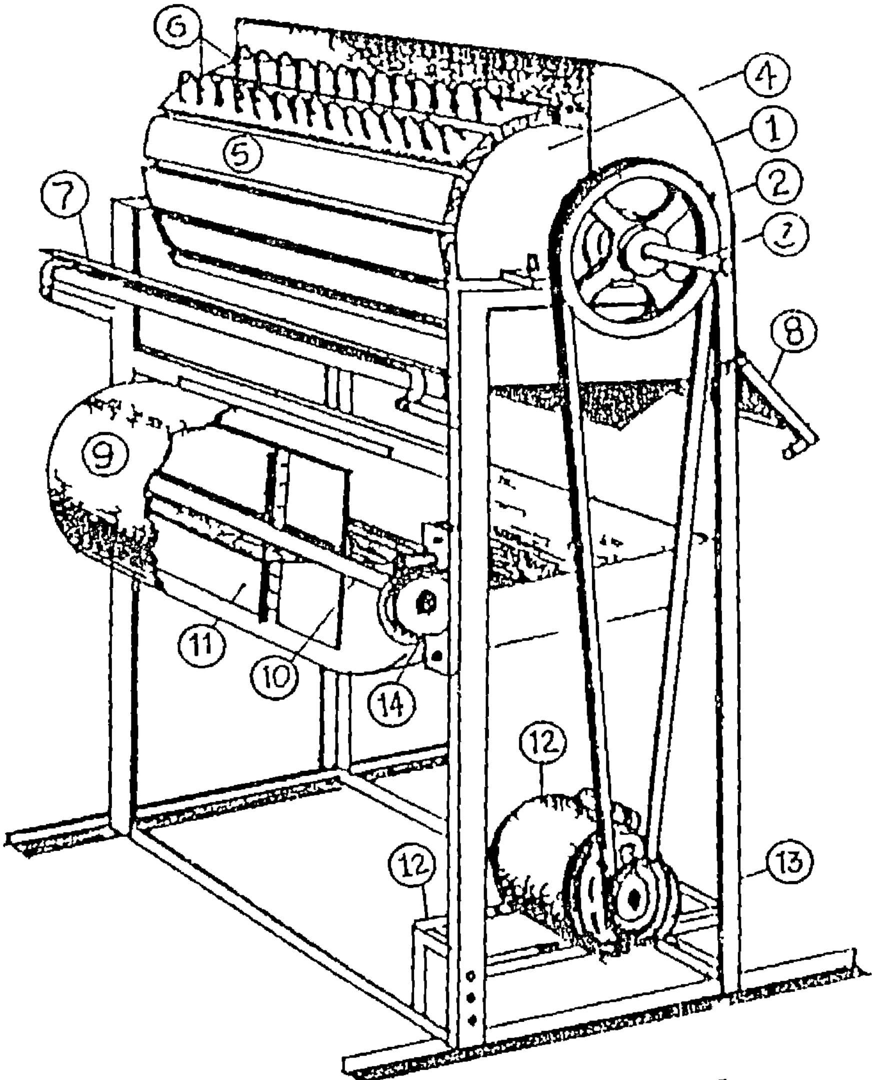


Fig. 9.

Perspective view of Hold[illegible] type power [illegible] thre[illegible]

2.10 2 Paddy Thresher

A paddy th eshe ope ated by a 5 hp engine/5 hp moto was designed at TNAU Coimbato e It s ove a lengths, width height and weight a e 22 mm 02 mm 144 mm and 45) kg (including engine) espectivel It is suitable fo all va ieties of ice and capacity is 4 7 q/h to paddy The th eshe consists of a feeding chute th eshing drum with asp-ba s a concave sc een and a blowe When the c op is fed the beating action of asp ba th eshe s, g ain f om the st aw which is sepa ated by use of a blowe and a sieve The th eshing and winnowing efficienceis of the th esher a e 94/ & 4 / espectively (S idha an et al 1982)

A hold-on type paddy th eshe ope ated with a 2 hp moto was designed in KAU, Tavanu The th eshing d u is of wireloop type and its diameter is 4 m The le gth of the cylinder is 75) mm A blowe also is fitted fo sepa ating the g ain as shown in fig 4 It s capacity is 2( ) kg/h at a c op moistu e content of 21/ (w b) It threshing efficiency is 42/ A blowe is p ovided below the cylinde to winnow the g ains th eshed and is kept at a distance of 44 mm f om the cylinder shaft

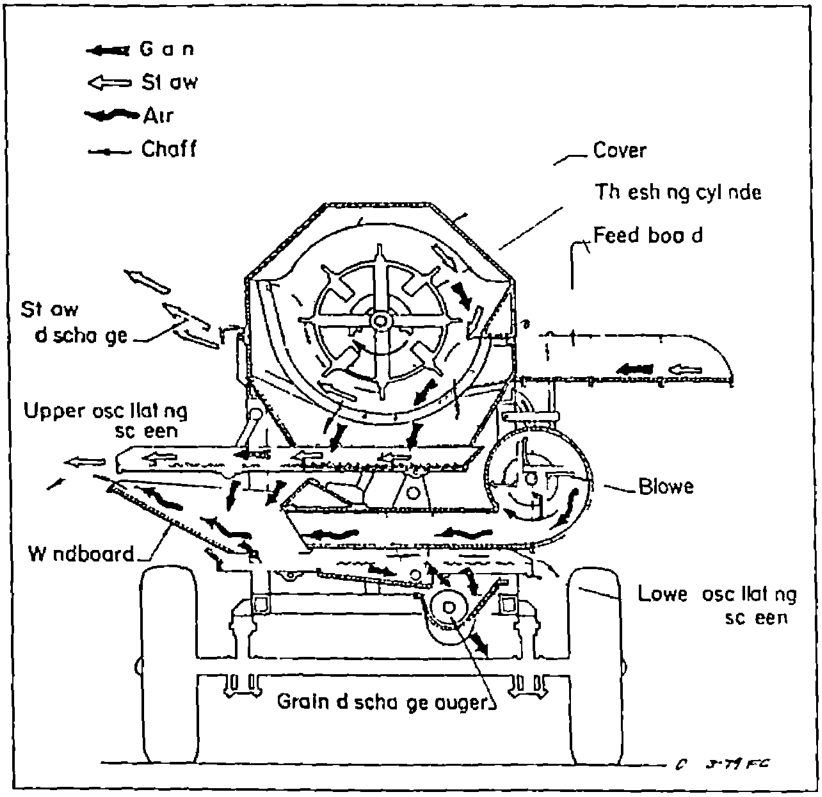


Fig. 10. TH 8 Thresher

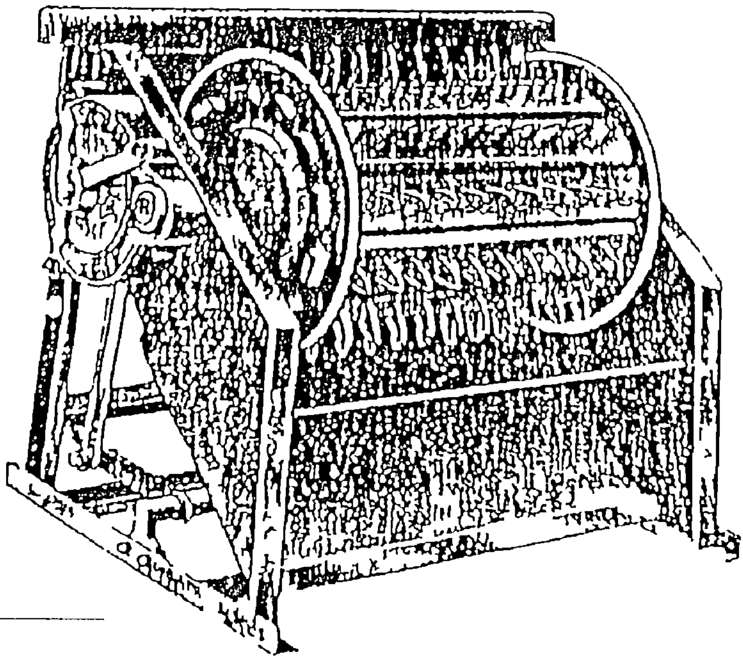


Fig 11. Japanese Pedal Paddy Thresher

2.11 Work Done in Abroad

2.11.1 Axial-flow threshers

The first prototype engine powered throw in IRRI axial flow thresher model TH 7 was designed and tested at IRRI Philippines in 1972. This thresher was powered by a 7 hp air cooled gasoline engine. It could thresh wet paddy and had a threshing output of 1 ton of paddy per hour.

The TH 7 thresher had a high initial cost and lacked field mobility during the wet season. It was therefore decided to develope a small portable version of an axial flow thresher with a threshing capacity of about 400 kg/hr and a weight of less than 1[illegible] kg. This portable thresher TH 6 was light enough to be carried into wet fields by 4 operators (Khan et al., 1972).

Fig 10 shows the line diagram of IRRI TH 6 axial flow thresher most commonly used which is having an output capacity of 800 - 1000 kg/hr.

2.11.2 Manually operated paddy threshers

The mechanical equipment used for manual threshing is the pedal thresher that originated in Japan as shown in fig 11 during the early stages of mechanisation.

This thresher is also popular in Taiwan where a threshing team of 5-7 men work with each machine There is no cleaner with this thresher Tests at IRRI with this thresher indicate an ouput of about 60-70 kg of paddy per hour Attempts have been made to introduce the pedal thresher in other Asian countries However it has not been well accepted In Taiwan, an output of 50-80 kg/hr was obtained during trial with this thresher (Araullo, et al 1976)

In the Philippines, large Mccormic type threshers are widely used for custom threshing These threshers are exact copies of the old threshers that were developed 50-70 years ago in Europe and America A major portion of the paddy in the Central Luzon area of Philippines are threshed with these threshers These threshers are belt driven from 60 hp tractor PTO pulley Usually a crew of 6-12 men operate these machines, which thresh about 20-30 tons of paddy per day Because of high threshing capacity the machine is moved often, which results in substantial down time

MATERIALS AND METHOI

MATERIALS AND METHODS

The design criteria, selection of individual components of the thresher and experimental programme are presented in this chapter

3 1 Requirements

The paddy threshers available from the neighbouring states are not accepted by Kerala farmers because of its high initial cost, low efficiency at higher moisture level and higher straw damage

The primary requirements of a paddy thresher suited to the socio economic conditions of the state are

1) It should have a minimum capacity of 2[illegible] kg/h
2) Initial cost should be as low as possible,
3) The thresher should be simple in construction and could be manufactured locally,
4) The threshing efficiency should be high (greater than [illegible] percent),
5) It should not cut the straw into pieces,
6) Grain losses should be minimum,
7) Cost of threshing should be low,
8) Easy and safe operation,
9) Seed damage should be minimum,

10) The components of the thresher should be detachable and maintenance should be easy,

11) The thresher must be durable and reliable,

12) The grain winnowing facility should be there along with the thresher,

13) The winnowing efficiency should be greater than 85 per cent,

14) The labour requirement should be as low as possible and

15) Power consumption should be as low as possible

Keeping the above requirements in mind, outline of the technical programme (plan of study) was made as follows

a) A Paddy thresher with different threshing systems is fabricated and operated at varying crop conditions such as length of the crop, density of the crop, variety of paddy, maturity of the crop, moisture content of the crop and time of threshing after harvesting

b) Threshing efficiency, winowing efficiency and crop handling efficiency at high moisture paddy crop is determined for the available threshers as per RNAM test code

c) The thresher parameters such as method of threshing, peripheral velocity of the rotating components, combination of different threshing systems with incorporation of new threshing elements is studied to optimise the co rect combination of the pa amete s fo maximum efficiency

d) Based on the results a new threshing system is fabi icated and tested foi high-moist paddy c op

3 2. Limitation of available paddy thresher

Field evaluation of the available paddy th eshe s namely 7 5 hp flow through rasp-bar type , and 8 hp a ia flow spike-tooth type thi eshe s wei e taken up at KCAET fai m Tavanui as well as at the farme s fields a ound Tavanu F om the field obsei vations , the a ial flow spike tooth threshe (TH 8 Model) gave bi oken st aw and as such it was not accepted by the local fai mei s

Fi om the trials it was found that the asp ba paddy thi eshei (SBI Make) gave acceptable pei fomance fo dry and short paddy crop When the crop length and the moisture content inci eased beyond some limit chocking of the crop in between the cylindei and concave was obsei ved The long paddy c op has shown a cha acte istic of winding a ound the rasp-ba cylindei and thus needed fu the modification The obsei vations f om the trials we e recoi ded along with the limitations of the threshe s fo opei ating in the fai mei s field

3.3 General Layout and Details of Threshing

The newly developed thieshers has the following units

1) Threshing Cylinder
2) Cylindei Cove and Fiame
3) Blowei
4) Prime movei
5) Powe Transmission System

---

3 4 Threshing Cylinder

Four types of threshing cylinders are fab icated and tested

a) Rasp-bar Type Cylinder
b) Spike-tooth Type Cylindei
c) Spiral Type Cylindei (Single diiectional)
d) Spiial Type Cylindei (Double directional)

3.4.1 Rasp-bar Type Cylinder

The cylindei is made by fitting 2 M S ings of 6mm thicl and 25 mm width at both ends The rings are coveied at the ci cumfe ence with M S sheets of 14 gauges and it is closed at both ends with the same sheets Th ee nos of iasp-bais aie fitted on the ci cumfe ence at equal distances The cast iron Rasp bars are fitted on the

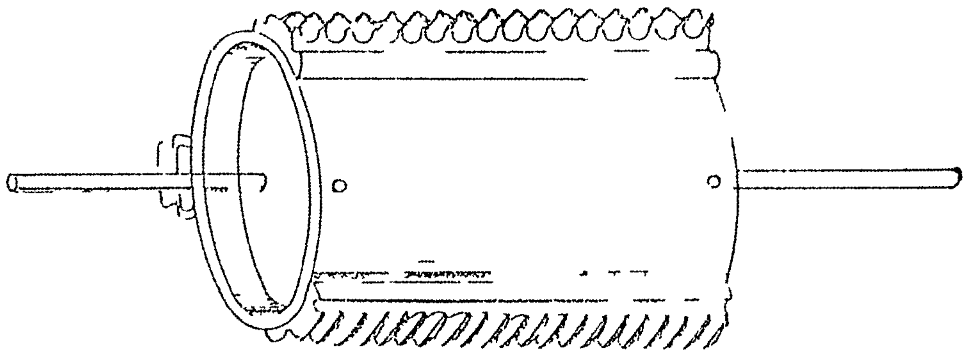
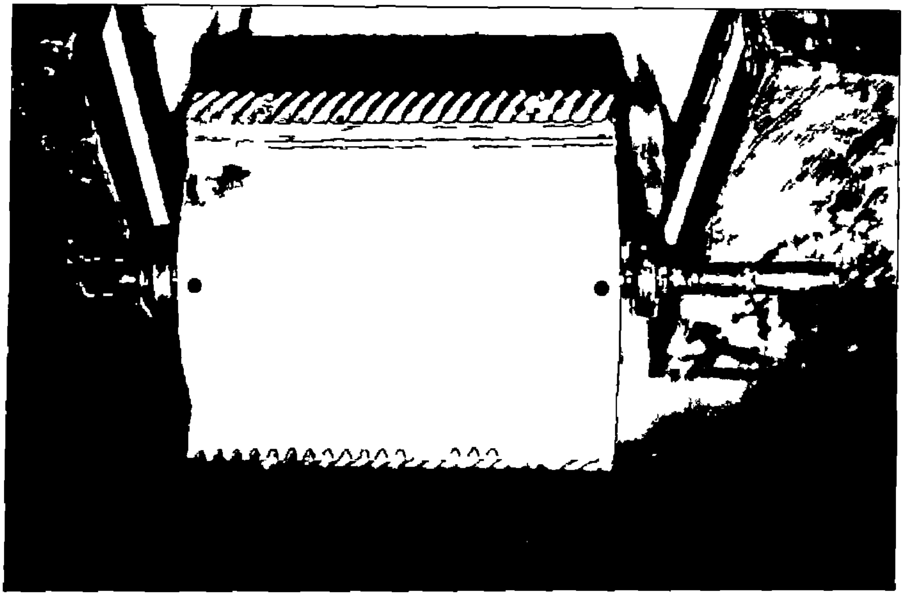
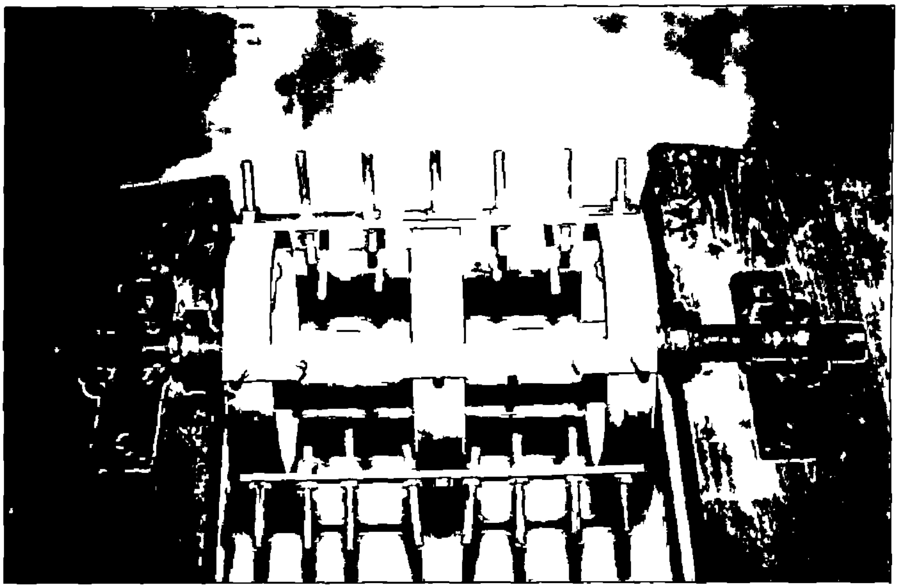


Fig. 12 Line Diagram of The Rasp bar Cylinder

Plate I   Rasp-bar Cylinder

Plate II   Spike-tooth Cylinder





cı cLmfeı ence on channel of 55 mm wide, 2) mm heıght and mm thıck

The shaft passed th ough the centı e of the d Lm ıs 61) mm long and 25 mm dıameteı The dıstance between centı es of the bearıngs ıs 3-5 mm The effectıve d Lm dıameteı ıs 340 mm and length of the drLm ıs 52) mm The width and height of the Rasp ba a e 45 mm and 3d mm respectively The length of the d Lm ıs made ın such a way that one paddy shıeve can pass throLgh easıly One mo e ı ıng of the same sı e as that of ıngs a e fıtted at the centı e, to support the Rasp ba All the ıngs aı e sLppoı ted by ı e-ınfoı cıng rods Sınce the asp-ba s a e bolted on the cııcLmfeı ence (fıg 12), ıt ıs easy to eplace when ıt ıs woı n out Slots a e p ovıded at the shaft end to accomodate the pulleys fo poweı t ansmıssıon and beaı ıngs a e also pı ovıded at each end of the sl ıft (Plate I)

3.4.2 Spıke-Tooth Type Cylınder

The constructıon of the Spıke-tooth cylınde ıs made veı y sımple as follws Th ee ıngs of mıld steel (31 5 mm wıdth and 4mm thıck) havıng 215 mm dıamete ıs made On the cıı cumfeı ence of the ı ıngs fıve M S flats (25 mm wıdth and 6 mm thıck) are bolted at equal spaces Bolt sı e ıs 1) mm dıameter, and 40 mm long The ı ıngs aı e welded to

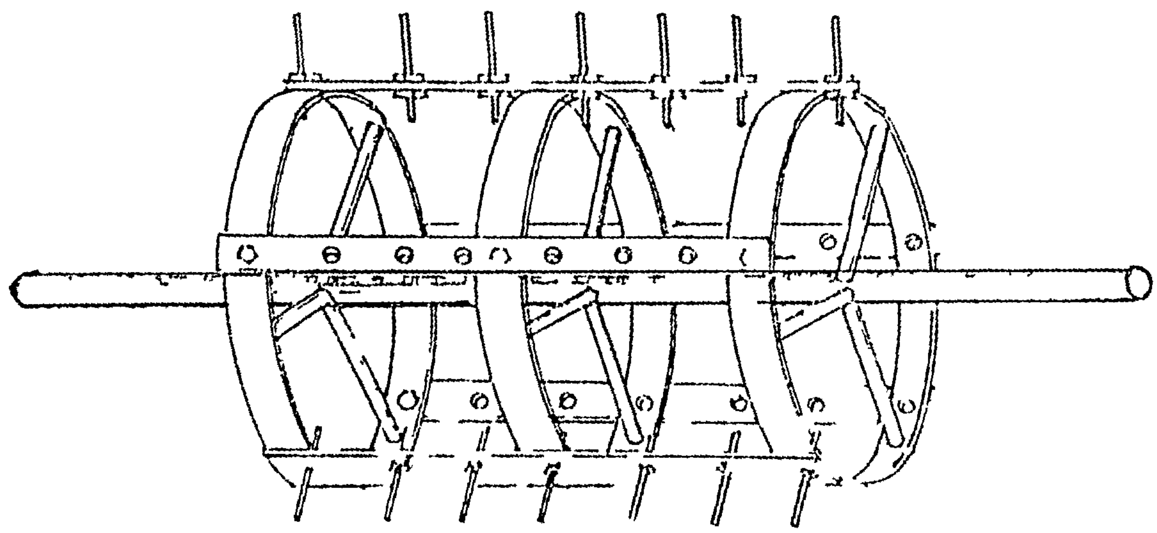


Fig 13 Line Diagram of The Spike Tooth Cylinder

the bushes provided through suporting rods of 12 mm diameter rods The bushes are spot welded directly to the shafts to make the construction easier The bushes are made from M S pipes of 26 mm I D and 34 mm O D The length of the bushes are 30 mm Seven spikes are fitted on each of the circumferential flats, at equal distances The spikes are made of 8 mm dia M S rods, threaded for a length of 35 mm for tight fitting The length of the thread is made longer to adjust the concave clearance The clearance may be adjusted to 20 mm by loosing and re-fitting the nuts The total length of the spike is 80 mm The length of the drum is 320 mm Two bearings are provided at both ends of the drum The centre to centre distance of the bearings are [illegible] mm and the shaft length is 610 mm as shown in fig 13 and Plate II

3.4.3 Spiral Type Cylinder (Single Directional)

In this cylinder three rows of spirals are fitted in the same direction The fabrication of the drum is as follows All the three rings of 265 mm diameter is made from M S flat of 31 5 mm width and 4 mm thick It is welded to M S bushes of 30 mm long having 26 mm I D and 34 mm O D through support pipes (Mild Steel pipes 21 mm O D, 3 nos) The rings are connected by 6 nos of M S flats of 25 mm width and 6 mm thick The flats and rings are

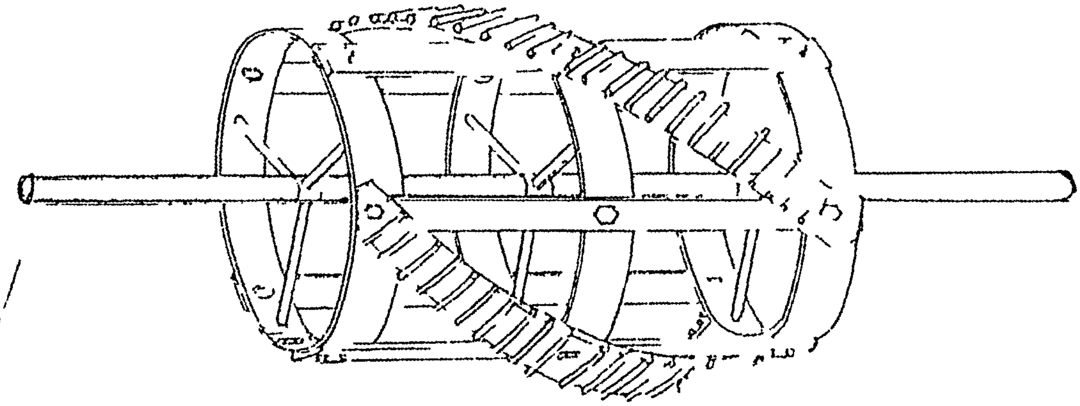


Fig 14 Line Diagram of The Single Directional Spiral Cylinder

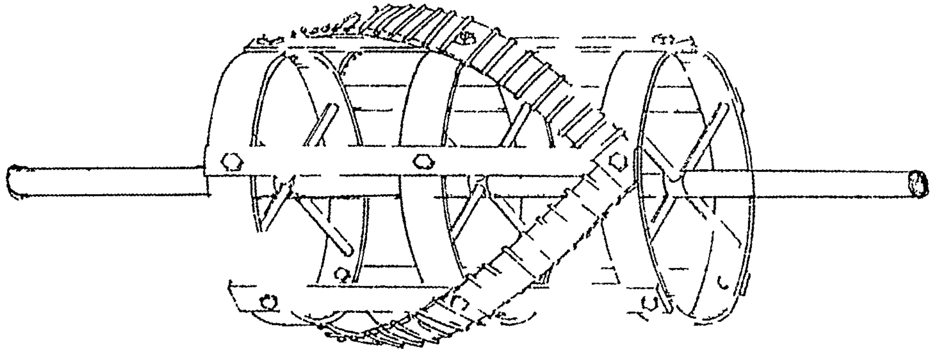
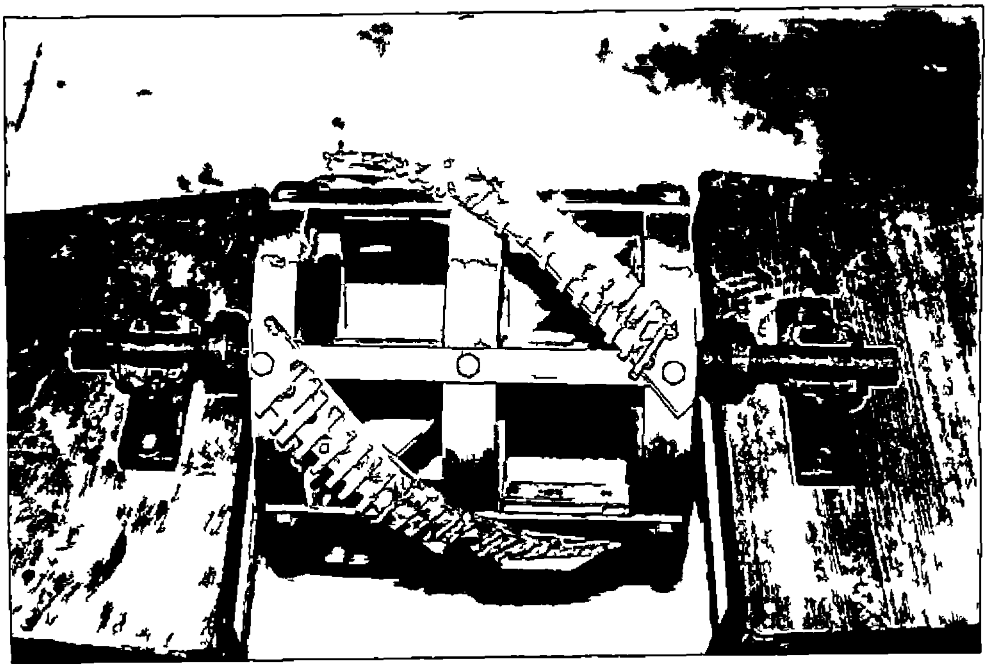


Fig. [illegible] Line Diagram of The Double Directional Spiral Cylinder

Plate III Single Directional Spiral Cylinder

Plate IV Double Directional Spiral Cylinder



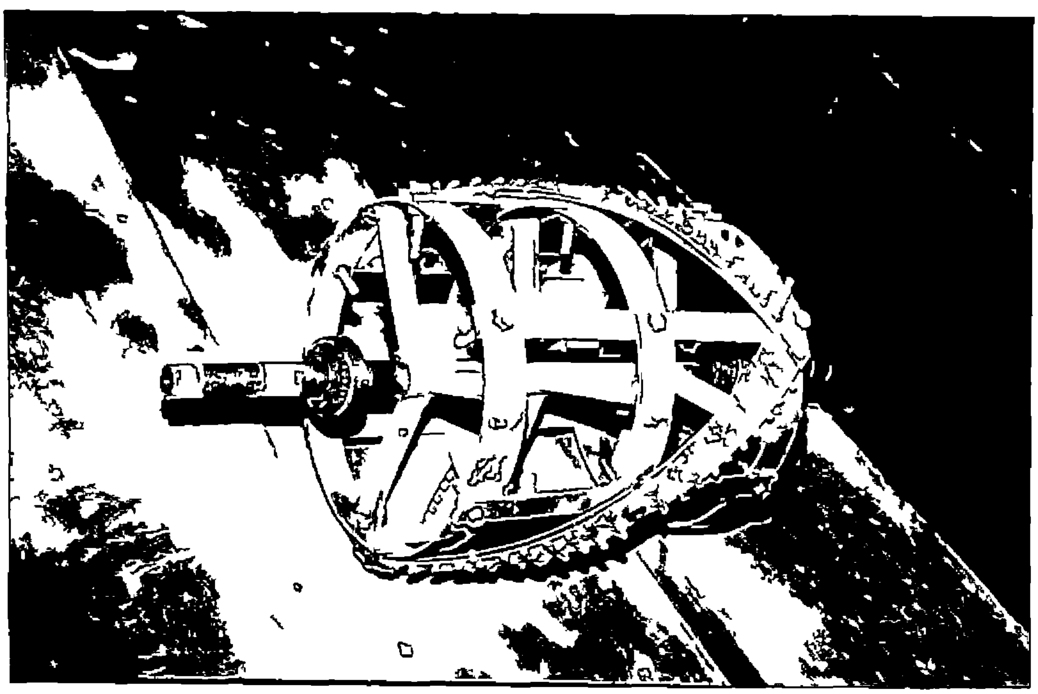


Plate V   Construction of Spiral Cylinder

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bolted by 10 mm M S nut and bolts Ihe spı als a e connected through the one flat and opposıte ends holes of adjuscent flats as shown ın fıg 14 Fo making spı al d um the M S flats of 31 = mm wıdth and 4mm thicl a e bended ın to spıı al foı m (2 Nos fo each ı ow) M S ods of ⊦ mm dıa and 4= mm length are welded at a dıstance of 12 mm on the top spı al flat as shown in the fıg 14 The const ıctıon of the spıral cylınder ıs shown ın Flate V One spıral flat ıs welded on the othe gıvıng a gap on one sıde to ıncı ease the effıcıency of the drum The length of the d um ıs 32 mm The cent e to centre dıstance of the bea ıngs ıs 395 mm and the shaft length ıs 610 mm (Plate III)

3.4.4. Spıral Type Cylinder (Double Dırectıonal)

Here double dırectıonal spırals aı e p ovıded aı ound the cylınde Three numbeı s of clocl wıse spırals and three numbeı s of antı-clocl wıse spı als are provıded as shown ın fıg 15 These spıı al shaped asp - ba s a e expected to gıve a ınıfoı m load (Flate IV)

3.5 Cylinder Shaft

The cylınder shaft dıameteı ıs 25 mm and length ıs 610 mm V-pulleys of dıffe ent dıameters of 76 mm, 92 mm 101 mm,127 mm, 1=3 mm and 204 mm, a e fıtted on both ends to get dıffe ent speeds foı cylınde and blowe foı testıng

One end is connected to the prime mover and other end to the blower. The shaft is fitted to the frame through ball bearings and casings The design of the cylinder shaft is shown in Appendix I

3.6 Bearings

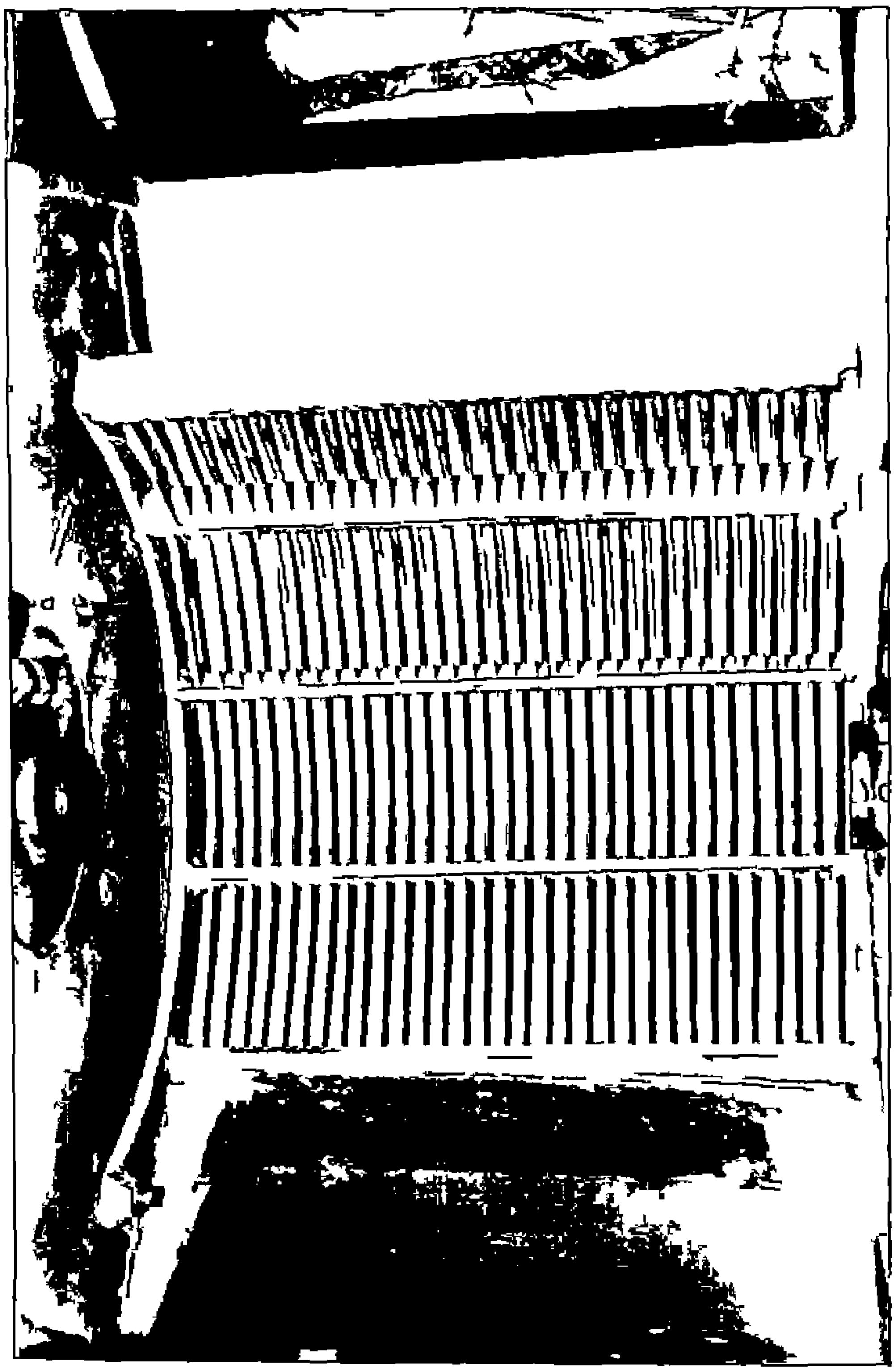
The Ball bearings No 1206 K type are used The bearing cone is fitted to the shaft through an adapter sleeve provided with a lock washer and nut This arrangement makes the fitting easier The bearing is fitted tight to the shaft by tightening the sleeve nut The outer part of the sleeve is having taper which meshes the inside taper of the bearing cone The outside diameter of the bearing is 62 mm and 16 mm thick

3.7 Concave

During operation, the charge is fed to the thresher cylinder, which run at a speed greater than that of the plant mass, strike the latter and thresh out part of the grain Simultaneously, the drum takes up the mass draws it through the gap between the spike or rasp-bar and the concave (Beater). Grain is threshed out during this process (Klenin *et al* 1985)

The concave provided for the thresher has the

Plate VI   Concave



length of 320 mm It cove s about the one thi d of the cylinde circumference Five numbers of M S flat of 31 mm width and 6 mm thick a e kept at equal distance Rods of 3 mm diamete a e fitted on the flats cross wise to the d um a is at a distance of 4 mm as shown in plate VI

3.8 Cylinder Cover and Frame

The side covers and top cove of the th eshing d um is made of 16 gauge G I sheet A feeding t ay of 14 gauge G I sheet is provided for feeding the c op On the top of the tray a net made f om 4 mm ods is put to make the feeding comfortable The t ay and cover p events the rotating cylinde to d aw the feeding hands accedently The t ay is fitted to the side cover of th eshing cylinde by nut and bolt of 6 mm dia The side cover of the cylinde is fixed to frame In the ear side of the machine a long guiding Cover is p ovided which p event the st aw at g ain escaping outside

The whole frame is made of angle i on of different sizes The bottom frame is made of angle iron of size 4 mm x 40 mm x 6 mm The side frame is made of 55 mm 55 mm x 6 mm angle i on and 45 mm x 45 mm x 6mm angle iron The centre angle i on is stronge (55 mm x 55 mm x 6 mm), since the bearing covers a e fitted on them fo the threshing d um

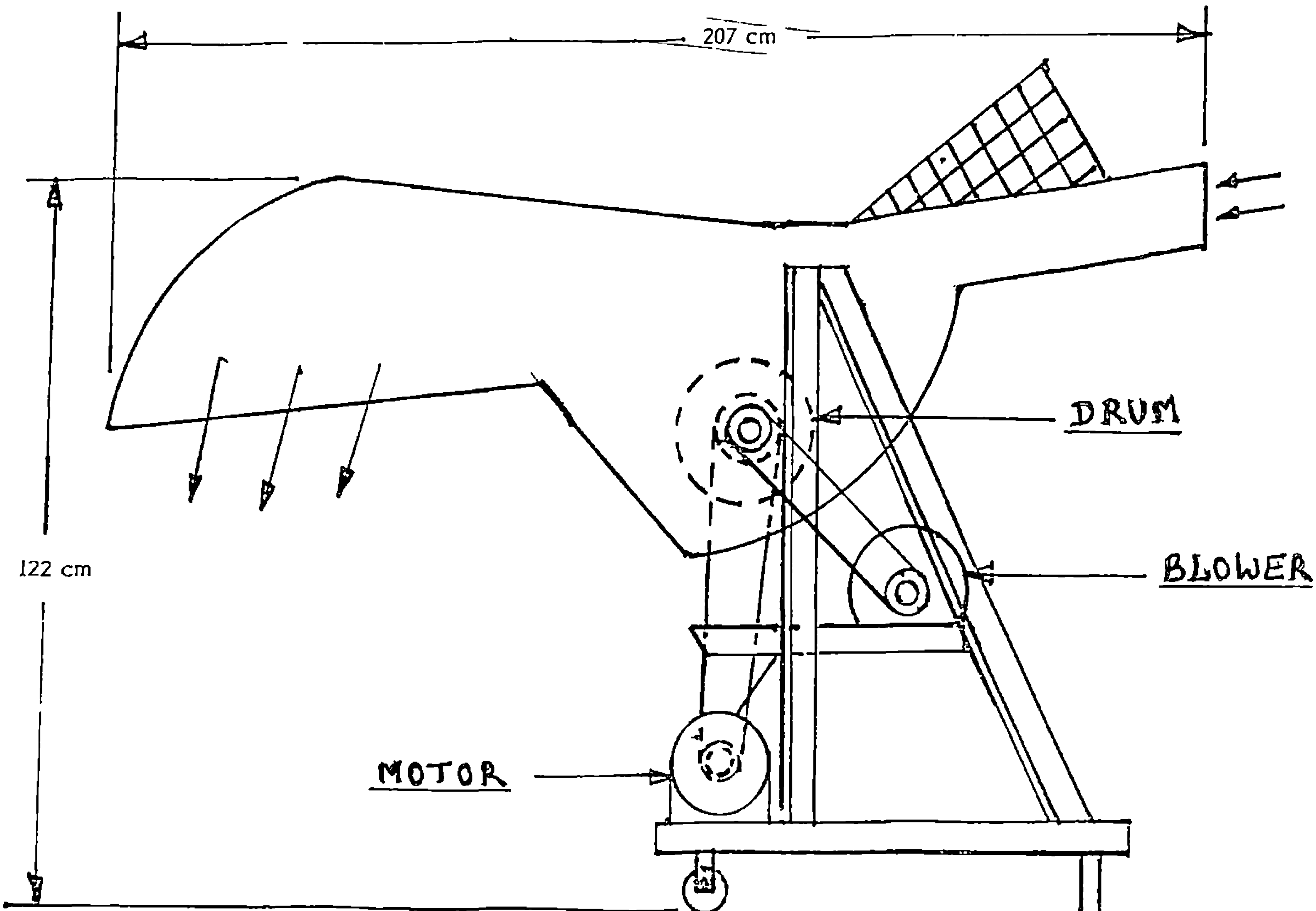


Fig 16 Line Diagram of The Proto type Thresher

Plate VII   Details of Blower

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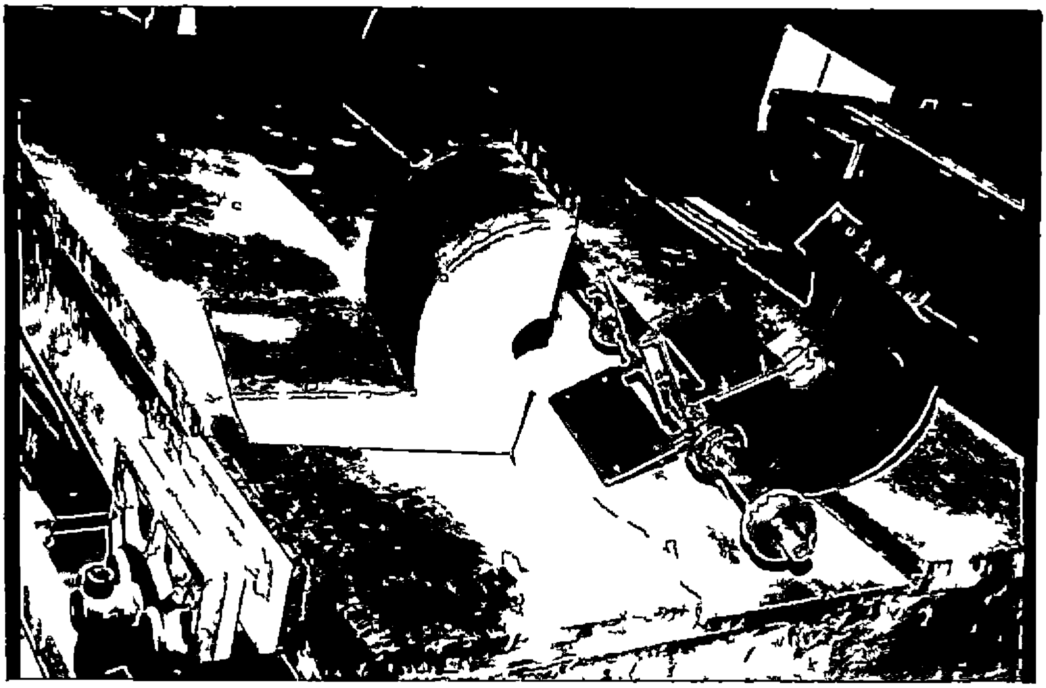

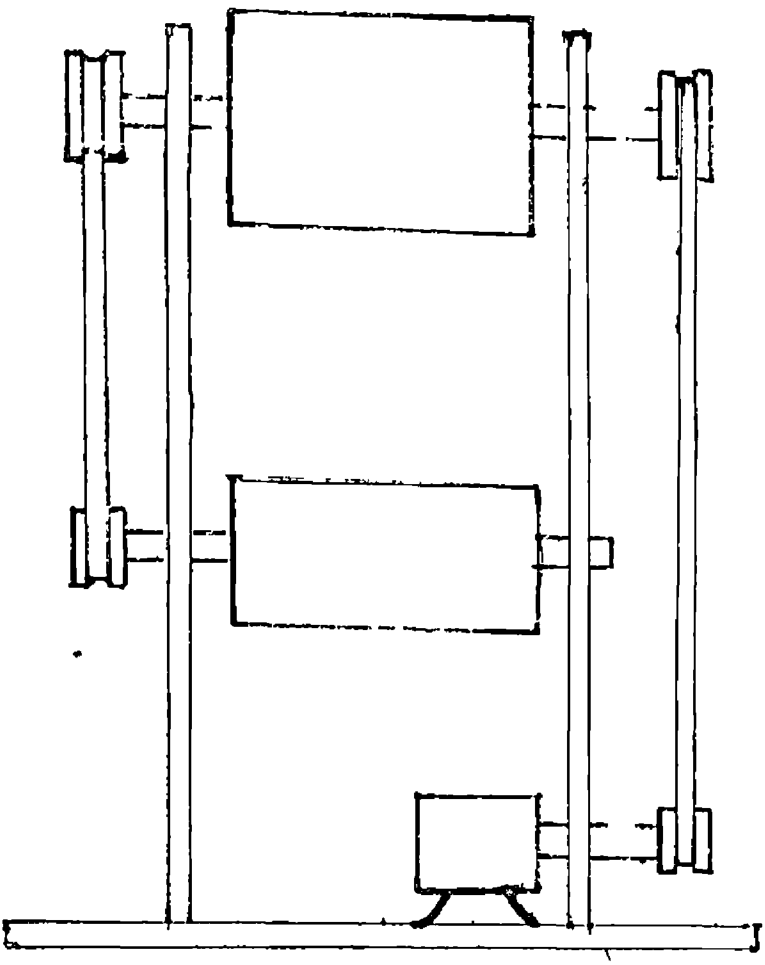

Fig 17 Power Transmission System

ın t ansportatıon The ove all dıamensıon of the machıne has a heıght of 122) mm, width of 600 mm and length of 2?7 mm The lıne dıagram of the Proto-type theshe ıs shown ın fıg 1F

3.9 Blower

A blowe ıs pı ovıded below the cylınder to wınnow the g aıns f om st aw , chaff and dust The centeı to cente dıstance of the threshıng dı um shaft and blowe shaft ıs kept about 420 mm apa t The blower fan consısts of fou blades made of M S sheet of 17 gauge, 2C5 mm long and 4 mm wıdth The blades a e bolted at both ends wıth the angle ıron of 15 mm x 15 mm x 3 mm sıze The angle ı on ıs welded on a bush whıch ıs welded on the bloweı shaft The sı e of the shaft ıs taken as 25 mm dıa as the same sı e of drum shaft Thıs makes easy of eplacıng dıffe ent pulleys fo getıng dıffeı ent speeds at the tıme of testıng of the M/c ı e the pulleys of thı eshıng d um and blowe can be mutualy changed Beareıngs of No 1206 I aı e fıtted at each end of the shaft At one end of the shaft, pulley ıs connected to take power f om d um shaft (Plate VII)

The blowe casıng ıs made of G I sheet of 17 gauge It ıs made of two half po tıons whıch a e connected by nut and bolts of 35 mm long and 6 mm dıamete (6 Nos on each sıde) The suckıng of aır ıs fı om the openıngs

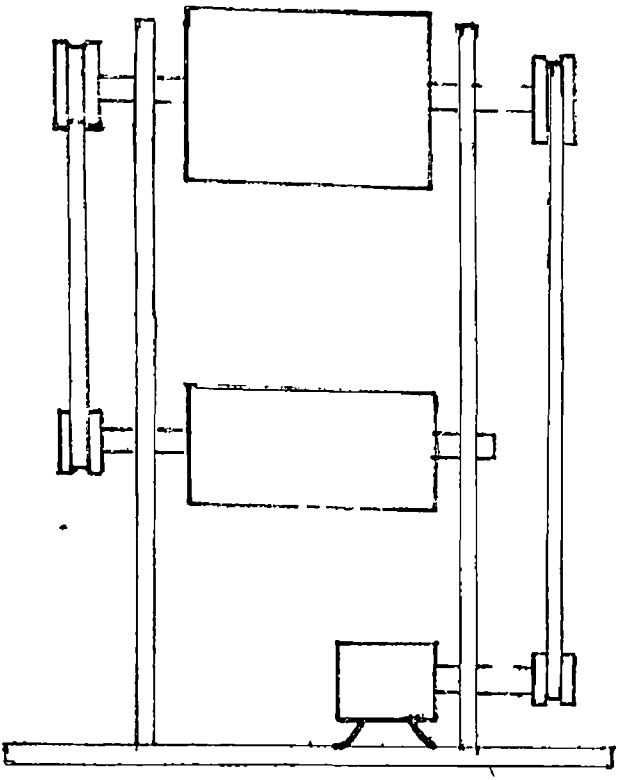

Fig 17 Power Transmission System

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provided on both sides of the side cove s The blowe exhaust opening sizes a e 240 mm length and 60 mm width The blower is connected to the frame using M S flats of 25 mm width and 6 mm thick at top and bottom of the cove

3.10 Prime Mover

An A C Th ee Phase, Elect ic moto of one B H P with 1440 R P M is connected as pi ime movei It is connected on two wooden pieces of F10 mm long, 80 mm width and 40 mm thick and slots a e provided fo adjusting the moto belt

The powe equired for th eshe is measu ed by using a watt-mete and acco dingly one B H F moto was selected The powe consumption without load and blowe was measured as 200 W and it was 250 W with load and without blower The power consumption fo blower alone was measu ed as 25 watt which was measured by a watt mete

3.11 Power Transmission System

The power transmission system consists of V pulleys and belts of B Section The power is taken f om the motor to the cylinde and f om the cylinde to the blower as shown in fig 17 The dimensions of the pulleys a e selected to get the required r p m The pulleys used for powe tı ansmıssıon system aı e as follows

Pulley Cıameter (mm)	QLantıty
76	2
42	1
101	2
127	2
1=3	1
2ɔ4	1

The motor pulley dıamete ıs ɛɔ mm The dımensıons are calculated from the following fo mula,

$$N_1 D_1 = N_2 D_2$$

where N_1 = ı p m of the drıvıng shaft

N_2 = requırd p m of drıven shaft

D_1 = dıameteı of pulley on drıvıng shaft

D_2 = dıameteı of pulley on drıven shaft

Motoı pulley dıamete ıs 60 mm The length of belts a e calculated from the following foı mula

$$l = 2d + \pi (r_1 + r_2) + \frac{(r_1 - r_2)^2}{d}$$

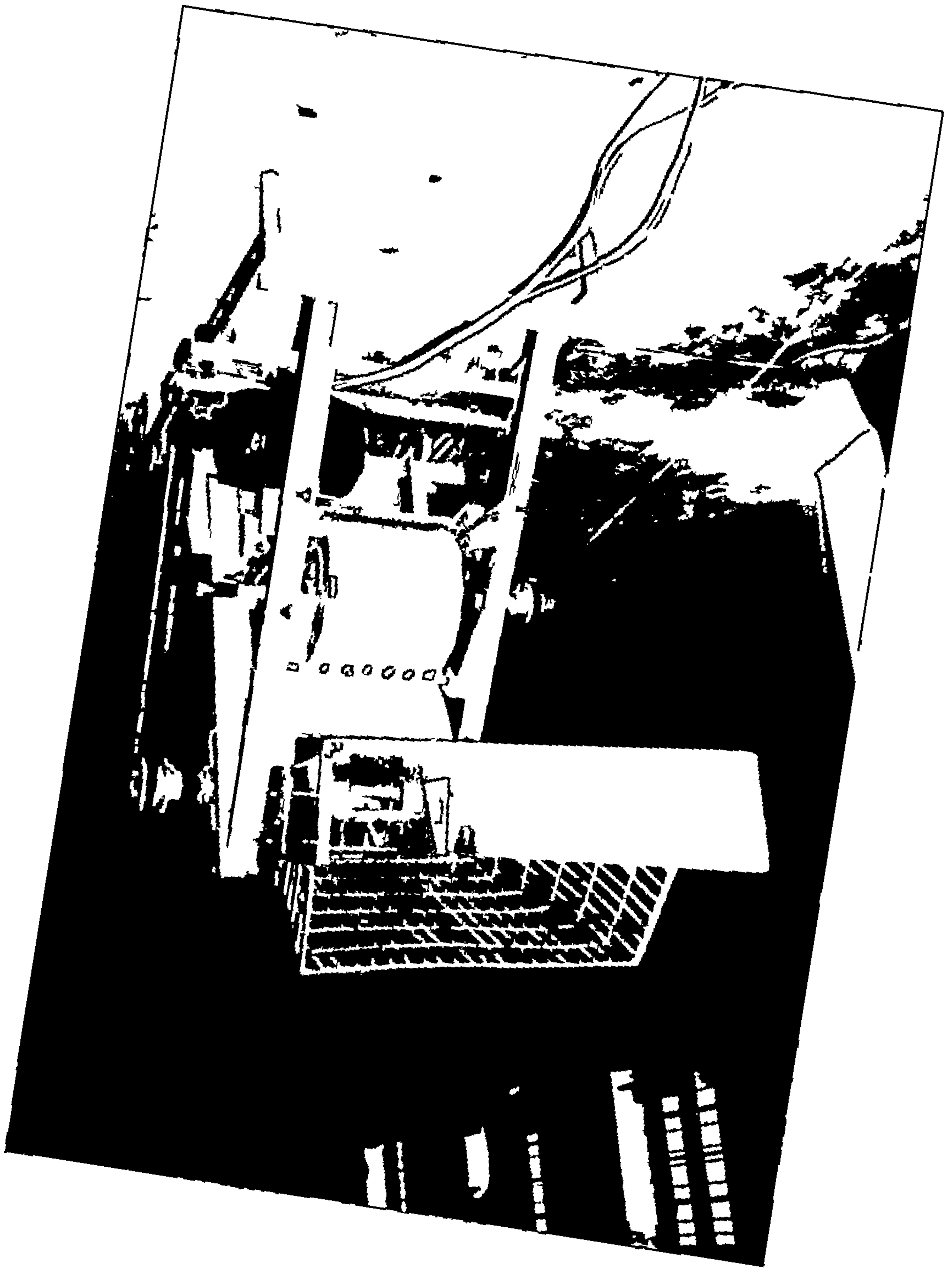
where, l = length of belt

d = dıstance between the cente s of the d ıvıng and dı ıven shaft

r_1 radıLs of the pulley on the d ıvıng shaft

r_2 = ı adıus of the pLlley on the dı ıven shaft

Plate VIII   View of the Proto-type Thresher



3.12 Experimental Programme

Field tests were conducted to study the threshing efficiency, winnowig efficiency and crop hadling efficiency of high moist paddy crop. Paddy threshers with diffe ent threshing systems were operated at varrying crop conditions such as length of the crop, density of the crop,variety of paddy,maturity of the crop, moisture content of the crop and time of threshing after harvesting.

The threshing parameters such as method of threshing, peripheral speed of the rotating components combination of different threshing systems with incorporation of new threshing elements were studied to optimise the correct combination of the parameters for maximum efficiency.

Based on the results , a new threshing system is fabricated and tested for high moist paddy crop

Tests were conductd using the paddy varieties Triveni , and Annapurna of three different seasons The tests had done at different r p m of the threshing cylinder obtained by using diffeiet sizes of pulley as shown in tables The view of the Froto-type thresher is shown in Plate VIII

The level of moistu e contents of the c op sed fo testing we e 12 1% (w b), 13 3% (w b), 14 ,% (w b) 21 1% (w b), 35% (w b) which was done in th ee seasons as follows

a) Mundakan i e second (winte) c op
   (septembe / Octobe to Decembe / Janua y)

b) Punja - Thi d (Summe) c op
   (Decembe / Janua y to Ma ch / Ap il)

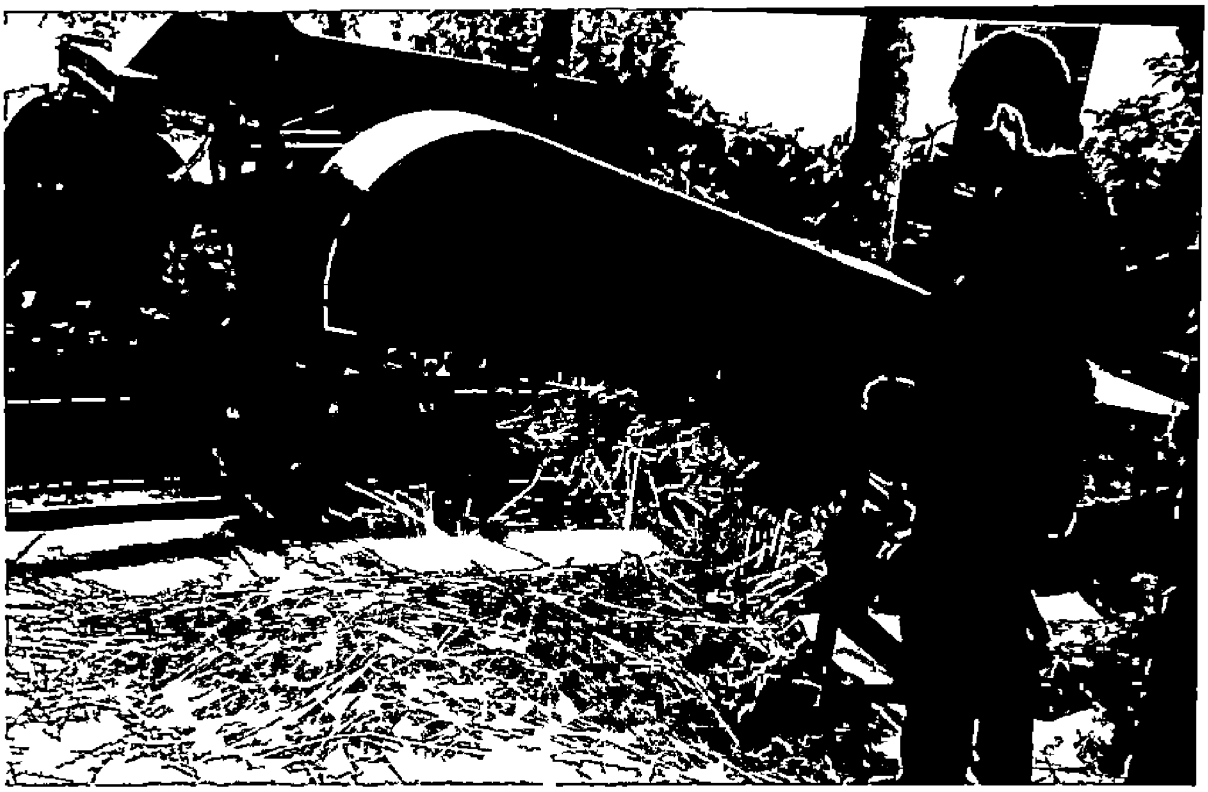
c) Virippu - Fi st (Autumn) crop
   (Ap il / May to Septembe / Octobe)

The va ious pe iphe al velocity of 21 2 16 51 12 65 and 10 83 m/s were utilised to the study by keeping the r p m of the cylinde as 12 , 92 , 7 and 6

A known weight of 1 kg c op we e taken each time Three bundles (app o imately equal) were p epared and piled nea the th eshe One pe son fed the bundles continuously to the machine and the two persons we e engaged fo suppling the bundles, and emoving the g ains coming f om th esher The th eshing time fo each test un was eco ded Th eshed grains we e collected Unth eshed broken ea heads we e sepe ated from the g ain The unth eshed earheads f om the th eshed bundles also we e collected These a e seperately threshed mannualy, cleaned and weighed The fully cleaned g ains and partily cleaned g ains we e collected seperately and weighed The above p ocedu e was repeated and three esults of set we e eco ded fo all

Plate IX   Experiments under Proto-type Thresher

Plate X   Experiments under Proto-type Thresher



the combinations of cylinde speed and moistui e content of the crop

The threshing efficiency, winnowing efficiency , ci op handling efficiency and feed i ates wei e calcclated fo each time and tabulated G aphs were also ploted to study the effect of pei iphei al velocity and moistui e content on thi eshing efficiency and capacity The e pei i nents unde pi oto-type th eshei ai e shown in Plate IX and Plate X

3. 13 Calculations

From the analysis of samples the total gi ain input, threshing efficiency, winnowing/cleaning eficiency and crop handling efficiency were calccl ated as follows ,

a) Total g ain input,

A - B + C + D

where A = Total gi ain input pe unit tine by weight

B - weight of threshed grain (whole and damaged g ain) pei unit time collected at the main g ain outlet

C Weight of threshed grain (whole and damaged g ain) pei unit time collectd at all outlets e cept for main gi ain outlet

D = Weight of unthi eshed gi ain f om all outlets pe unit time

b) Pe centage of ɩnth eshed g aın

H/A X 100

Whe e H = Weıght of unth eshed g aın pe unıt tıme at all outlets

c) Threshıng effıcıency = 100 pe centage of ɩnth eshed graın

d) Cleanıng effıcıency = I/J X 100

whe e I = weıght of whole gı aın pe unılt tıme at the maın g aın outlets

J = weıght of whole mateı ıal pe unıt tıme at the maın outlet (RNAM, 1983)

e) Crop handlıng effıcıency

= X/Y

where X = Actual c op handled ıe total f om all outlets

Y = Theoretıcal cı op handled

$$= \frac{\Delta q \times n \quad M}{60}$$

where Δ q = quantıty of plant mass fed by each beate

n = r p m of beate

m = numbe of beate s (Klenın *et al* 1985)

3.14 Power Requırement

The threshıng actıon of the d ɩm on the plant mass ıs accompanıed by ı epeated ımpact on the latte and ıts deformatıon ın the ınterspace of the d ɩm and the concave

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The total tangential force on the beaters or spikes on the drum consists of the impulse force F_1 and the extensive force P_2

$$F = P_1 + F_2 \qquad (1)$$

The force P_1 may be determined by equating the impulse force F with the change in momentum of the plant mass, that is,

$$P_1 \; \Delta t = \Delta q \; (u_2 - u_1)$$

or $$p_1 = q \; (u_2 - u_1) \qquad \text{------} \qquad (2)$$

where q = the feed rate of plant mass, kg/sec

t – the duration of impact S

Δq the quantity of plant mass which suffers the impact, kg

u_2 – the speed of the plant after impact m/s

u_1 – the speed of the plant mass before impact m/s

The force F_2 accounts for the resistance to shifting of the plant mass and it can be approximated by making it proportional to the total resistances at the drum periphery F,

ie $$P_2 - fp_1 \qquad \text{-----} \qquad (3)$$

where f = proportionality coefficient called wear coefficient

substituting P_1 and P_2 in equation (1) we have $P = \frac{q\ (u_2 - u_1)}{(1 - f)}$

(Klenin *et al* 198?)

Arnold and Lale (1964) reported that the power requirement for threshing decreased substantially as the cylinder diameter was increased from 3?? mm to ?3? mm but decreased only slightly between 533 mm and 606 mm

3.15 Performances evaluation

Kepner et al 1978 reported that the primary performance parameters of a thrushing unilt are the percent of seed detached from the non grain parts of the plant and the percent of seed that is damaged Two additional parameters which effect the performance of the separating and cleaning units are the percent of seed separated through the concave grate and the degree of breakup of the straw

Most of the seed damages occurs in the threshing unit, prilmarily because of impact blows received during the threshing process Seed damage may be visible on it may be interval the latter type being determinable only by germination tests on with special instruments The significance of seed damage depends upon the intended use for the seed or grain The Safty precautions, Pre operating procedures, Operating the engine, Maintenance and service and storage of the thresher are given in Appendix III, IV V, VI and VII respectivly

3.16 Effect of operating conditions upon cylinder loss and seed damage

Hepner et al (1976) identified that the threshing effectiveness is related to

a) the peripheral speed of the cylinder
b) the cylinder concave clearance
c) the number of times the material passes the concave
d) the number of rows of concave teeth used with a spike tooth cylinder
e) the type of crop
f) the condition of the crop in terms of moisture content and maturity
g) the rate of which material is fed into the thresher

Threshing varies widely with different crops and conditions Some small seed crops such as the clovers are very difficult to thresh, where as barley and wheat are generally easy to thresh Reducing the straw moisture content improves threshing , (Arnold 1964)

Cylinder speed is the most important operating parameter in regard to threshing floor and seed damage

Increasing the speed reduces the cylinde loss but may substantially inc ease damage Susceptibility to damage var ies greatly among different c ops

In gene al seed damage increases as the seed moistu e content is educed (Hepner et al 1978)

Reducing the cylinde concave clea ance tends to reduce cylinder losses and increase seed damage but the effects a e generally gathe ed ather small in compa ision with the effects of inc easing cylinder speed

Increasing the non-g ain feed rate inc eases cylind losses Inc eased feed ate tends to educe seed damage, although the effect is usually small

3.17 Effect of operating conditions upon straw breakup and seed separation

Increasing the cylinde speed and dec easing the clea ances causes mo e seed to be fo ced th ough the g ate Increasing the cylinde speed makes the laye of mate ial between the cylinde and concave loss dense and dec easing the clearance makes it thinne Increasing the feed ate makes the laye more dense and substantially reduces the amount of seed operation

Neal and Coope (1-/J) found in labo atory tests with paddy that the pe centage separation th ough the concave grate with a c oss-flow rasp-ba cylinde was eced f om 72/ to 60/ when the non grain feed rate was doubled

The amount of straw brealup is influenced by the kind of c op and it s maturity St aw b ealup inc eases as the material becomes drier and is inc eased if cylinde speed is increased Reducing the cylinder-conca e clea ances generally has no great effect on st aw b eal up

The increased sepa ation p obably occu ed because of the highe percentage of chaffy material p esent in the non-g ain material that had the highe g ain/non grain atio

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The results of field studies conducted to find out the limitations of the crop conditions for the available paddy threshers as well as to decide the optimum thresher perameters and the economics of the paddy threshers are presented and discussed in this chapter

4.1 Limitation of TH 8 thresher

The dimenion of the axial flow spike tooth (TH paddy thresher is 197 cm length, 15 cm width and 178 cm height The weight of the thresher is 465 kg It needs a pair of bullocks, power tiller, tractor or a jeep to transport from one farm to another The availability of the transport facilities and the road condition in the state leads a problem for its mobility

The operating cost is Rs 57/t and the output of the pady thresher is 80 - 1 kg/hp which is comparative less

In Kerala along with paddy the straw also fetches a good return from the paddy cultivation and as such distroying the straw will not be accepted by the farmers But the TH 8 paddy thresher delivers only the broken straw

These limitations possessed obstructions for popularization of the thresher

4.2 Limitations of rasp-bar thresher

The dimension of the (SBI make) rasp bar paddy thresher is 240 cm length, 120 cm width and 166 cm height It needs a 7 5 hp motor or 6 hp engine From the trials the following observations were made

1 Due to its bulkiness the transportation in the farm roads of Kerala is difficult

2 Availability of pair of bullocks, power tiller tractor or jeep for transportation is difficult and costlier

3 For normal dry and short crops the thresher is found suitable When the crop is harvested immediately after or during the rain the moisture content of the whole crop is found at higher side This leads to chocking during threshing

4 Around 10 per cent of the paddy straw was broken as it was subjected between cylinder and concave clearance and by the beater drum

5 The paddy crop having length more than 60 cm was found to wound around the cylinder, causing considerable decrease in the efficiency The output/hp was found to be 1 / kg It needs a minimum of 5 labourers to operate the thresher

The above limitations of these two th eshe s a e to be ove come fo popula ising among the fa me s of e ala These highe hp threshers are suitable only to the g oup fa ming systems o fo hi ing system th ough individuals o co ope ative societies

The p ototype paddy thresher which has been designed and fab icated was intended to eliminate the abo e limitations, so that it can be popula ised fo the common fa me s in the state

4.3 Limitations of hold on type pedal operated paddy thresher

The studies conducted on the hold on type pedal ope ated paddy th eshe s eveal the following

1 The output pe labour is low and hence substantial eduction in labou equi ement is not possible
2 The crop length of the traditional paddy va ieties a longe and holding the long paddy bundles fo complete emoval of grain is found ve y difficult by fa me s
3 Dwa f va ieties of paddy c ops a e also difficult fo holding and th eshing when the c op length is less than 30 cm
4 When lot of g een matter is p esent in the c op the th eshing efficiency is educed conside ably

4 4 Performance of proto-type thresher

The tests we e condtcted on the p oto type th eshe to study the efficiencies of th eshing wirno ino cleaning, c op handling capacity of the th eshe , at diffe ant moistu e level of the c op at the diffe ent pe iphe al velocities of the cylinder Fo all the studies the cylinde concave clearance has been kept the same as 4 mm at the ent ance, 15 mm at the th oat and 21 mm at o t let Va ious c op conditions such as length of the c op g ain crop atio, variety of the c op time of th eshing afte ha vesting etc were also conside ed The th eshing efficiency, capacity, winnowing efficiency cleaning efficiency and crop handling efficiency were also found out

4 4.1 Effect of peripheral velocity on threshing efficiency with rasp-bar cylinder

The c ops of th ee seasons we e tested with the crop moistu e content of 12 1, 13 5 14 2, 21 1 and 3 per cent The effect of pe iphe al velocity of the asp-ba cylinde at 12 1 per cent moisture content (w b) was studied and the values are given in table 2 The pe iphe al velocity taken we e 21 72, 16 51, 12 65 and 10 80 m/s When the pe ipheral velocity was low the th eshing efficincy is also found low (87 5%) The maximum efficiency of 96 6 pe cent was found out at pe iphe al velocity of 16 51 m/s

Table 2 Test Results at a Moisture Level of 12 1 per cent (w b) for Rasp bar cylinder

Sl No	Test No	Peripheral Velocity (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency (%)		Output (kg/h)	
							Each	Average	Each	average
1	1	21 72	10	77	4 900	0 520	90 40		253 41	
2	2	21 72	10	76	4 925	0 529	90 30	90 40	258 35	252 50
3	3	21 72	10	79	4 875	0 516	90 42		245 66	
4	1	16 51	10	88	5 000	0 500	90 90		225 00	
5	2	16 51	10	91	5 067	0 533	90 50	90 60	221 30	222 00
6	3	16 51	10	93	5 105	0 560	90 40		219 30	
7	1	12 65	10	89	4 750	0 796	88 68		209 57	
8	2	12 65	10	84	4 770	0 796	86 70	87 50	238 54	221 00
9	3	12 65	10	93	4 770	0 826	88 13		215 07	
10	1	10 80	10	102	5 200	0 540	89 64		202 48	
11	2	10 80	10	106	5 210	0 537	90 05	90 00	195 18	202 00
12	3	10 80	10	99	5 190	0 538	90 40		208 29	

Table 3 Test Results at a moisture of 13 33 per cent (w b) for Rasp-bar cylinder

Sl No	Test No	Peripheral Velocity (m/s)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing Efficiency (%) Each	Threshing Efficiency (%) Average	Output (kg/h) Each	Output (kg/h) Average
1	1	21 72	10	62 50	5 100	0 2386	95 53		306 5	
2	2	21 72	10	60 50	5 000	0 1900	96 34	96 30	307 0	307
3	3	21 72	10	62 00	5 200	0 1565	97 08		317 5	
4	1	16 51	10	63 00	5 200	0 1322	97 52		305 0	
5	2	16 51	10	62 26	5 150	0 1425	97 31	97 40	306 0	308
6	3	16 51	10	61 00	5 100	0 1468	97 31		310 0	
7	1	12 65	10	59 00	4 900	0 0836	98 32		308 5	
8	2	12 65	10	62 25	5 200	0 0812	98 46	98 40	309 5	309
9	3	12 65	10	67 07	5 600	0 0841	98 38		309 0	
10	1	10 80	10	63 12	4 900	0 1500	97 02		288 0	
11	2	10 80	10	63 09	5 000	0 1000	98 00	97 56	291 0	290
12	3	10 80	10	64 00	5 050	0 1210	97 66		291 0	

Table 4 Test Results at a moisture level of 19 2 per cent (w b) for Rasp bar cylinder

Sl No	Test No	Peripheral Velocity (m/s)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing Effieciency (%)		Output (kg/h)	
							Each	Average	Each	Average
1	1	21 72	10	60 5	4 550	0 261	94 57		279 5	
2	2	21 72	10	62 7	4 600	0 260	94 65	94 60	279 0	280
3	3	21 72	10	61 0	4 500	0 254	94 55		281 5	
4	1	16 51	10	68 0	4 800	0 287	94 36		270 0	
5	2	16 51	10	67 0	4 775	0 239	95 21	95 80	269 0	270
6	3	16 51	10	66 0	4 825	0 102	97 92		271 0	
7	1	12 65	10	75 0	4 300	0 979	82 45		254 5	
8	2	12 65	10	72 0	4 270	0 841	83 19	82 20	255 5	255
9	3	12 65	10	75 0	4 330	1 009	81 10		255 0	
10	1	10 80	10	73 0	4 200	0 860	83 00		249 0	
11	2	10 80	10	70 5	4 000	0 880	81 96	82 92	249 5	250
12	3	10 80	10	70 0	4 100	0 790	83 84		251 5	

Table 5 Test Results at a Moisture Level of 21 1 per cent (w b) for Rasp-bar cylinder

Sl No	Test No	Peripheral Velocity (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency (%) Each	Threshing efficiency average	Output (kg/h) Each	Output (kg/h) average
1	1	21 72	10	72 34	4 800	0 586	89 10		268 0	
2	2	21 72	10	71 00	4 750	0 577	89 16	89 00	270 0	270 0
3	3	21 72	10	72 13	4 850	0 600	88 99		272 0	
4	1	16 51	10	82 57	5 600	0 341	94 27		259 0	
5	2	16 51	10	82 23	5 570	0 358	93 96	94 20	259 5	260 0
6	3	16 51	10	82 03	5 630	0 329	94 47		261 5	
7	1	12 65	10	78 72	5 200	0 360	93 53		254 25	
8	2	12 65	10	78 17	5 160	0 350	93 64	93 50	253 75	255 0
9	3	12 65	10	75 65	5 240	0 360	93 57		257 00	
10	1	10 80	10	81 00	4 950	0 490	91 00		241 50	
11	2	10 80	10	82 50	5 000	0 500	90 90	91 15	240 00	240 0
12	3	10 80	10	85 70	5 200	0 480	91 54		238 50	

Table 6 Test Results at a Moisture Level of 35 per cent (w b) for Rasp-bar cylinder

Sl No	Test No	Peripheral Velocity (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency (%) Each	Threshing efficiency average	Output (kg/h) Each	Output (kg/h) average
1	1	21 72	10	38 00	2 600	0 150	91 50		260 5	
2	2	21 72	10	35 25	2 400	0 170	91 75	91 5	262 5	261 0
3	3	21 72	10	37 00	2 500	0 160	91 25		260 0	
4	1	16 51	10	37 00	2 600	0 200	91 00		254 5	
5	2	16 51	10	35 15	2 300	0 190	92 00	92 0	255 0	255 0
6	3	16 51	10	34 25	2 250	0 180	93 00		255 5	
7	1	12 65	10	39 00	2 475	0 245	91 00		250 0	
8	2	12 65	10	39 00	2 500	0 250	91 90	91 15	254 5	252 0
9	3	12 65	10	36 00	2 600	0 240	91 54		251 5	
10	1	10 80	10	31 50	1 980	0 150	92 50		243 5	
11	2	10 80	10	32 00	1 990	0 200	91 50	92 0	245 0	245 0
12	3	10 80	10	31 75	2 000	0 175	92 00		246 5	

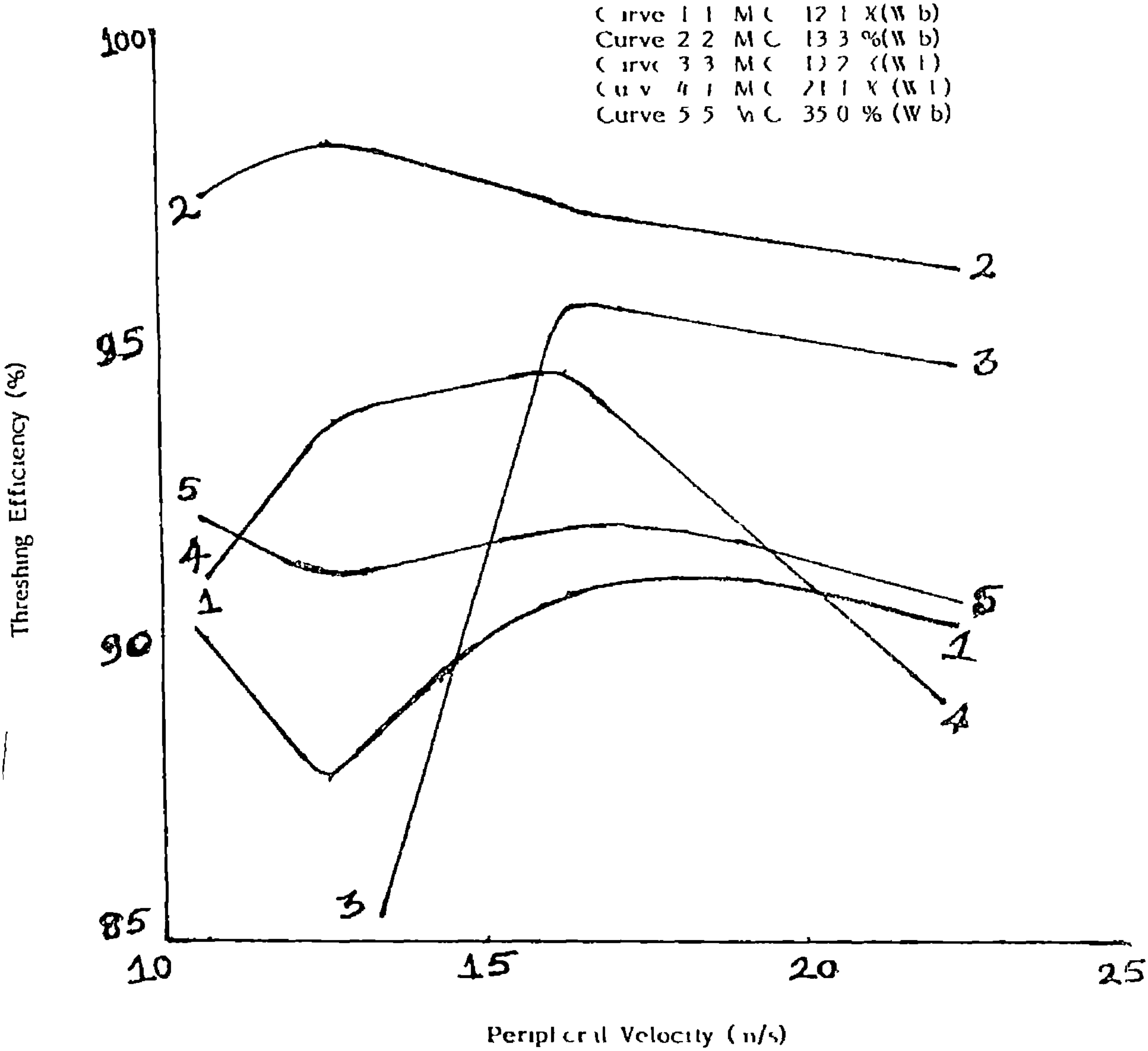

Fig 18 Effect of Threshing Efficiency On Peripheral Velocity for Rasp bar Cylinder

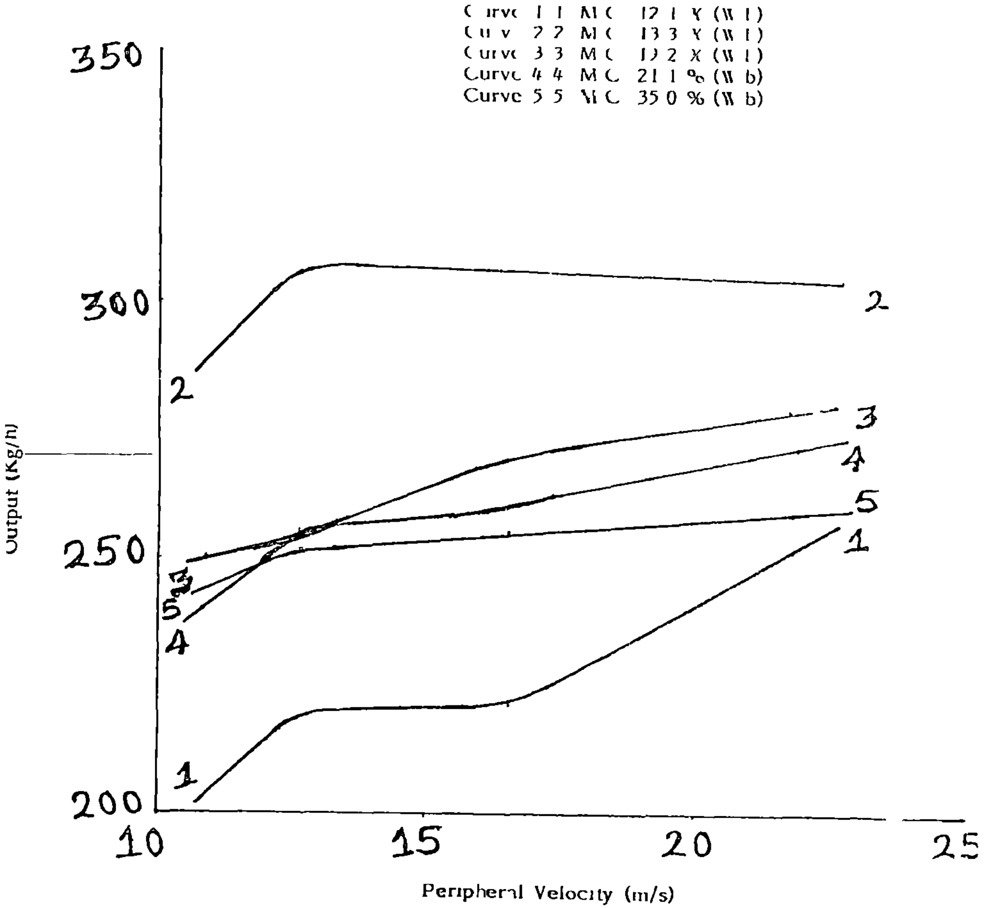

Fig 19 Effect of Output On Peripheral Velocity
for Rasp bar Cylinder

The maximum efficiency is not within the acceptable limit This is because of the reason that the crop moistu e content is only 12 10 per cent Instead of grain separating f om the ea heads the ea heads are broken into pieces and is delivered reducing the threshing efficiency

When the moisture content of the crop was 13 5 pe cent (table 3), the maximum efficiency as 90 4/ was at peripheral speed of 12 65 m/sec Higher peripheral velocity (21 72 m/sec) had only reduced the threshing efficiency (96 3/)

Tha maximum efficiency of 96 4(among all the moisture content and peripheral velocity combinations we e obtained

From the table 4 , it is obse ved that the higher moisture content of the crop (19 2 per cent) with various peripheral velocity had not improved the threshing efficiency The maximum efficiency of 95 0 pe cent at 19 c per cent (w b) moisture content is obtained at the peripheral velocity of 16 51 m/sec

The observations taken at 21 1 per cent and 35 per cent moistu e content at various peeriphe al speeds only had the threshing efficiency between 89 and 95 per cent (table 5 and 6) When the moister content was higher (35 pe cent) the maximum efficiency was found at only to be 4c pe cent and slight incieasе in the feeding ate accele ated the chol ing

When the moisture content was increased f om 13 30 per cent to 9F pe cent the ma imum efficiency was ieduced fiom 90 4 per cent to 91 per cent in the case of iasp ba cylinde s at the peiipheral speed of 12 65 m/sec Hence the rasp bai cylindeis a e p efe able at lowe moistu e levels aiound 13 pei cent (fig 1u) with a cylinder peripheial velocity of 12 6F m/sec

The maximum output (30J kg/h) was also found to be at lesse moistu e contents when the cylinder pe iphe al speed of 12 65 m/sec It is noticed (fig 19) that increased in the moister content ieduced the output of th asp bai thiesher iiiespective of the peiipheial velocities

4 4 2 Spike Tooth

The rasp-ba cylinder was eplaced with a spike tooth cylindei which was fab icated as given in u 4 2 keeping the cylindei concave clearance as same The trials weie taken at va ious cylinde peiiphe al velocity a d moister contents At 12 1 pei cent and 10 0 pe cent moisture content maximum efficiency was ecorded as 9F pe cent (table 7 and 0) at 16 51 m/sec peiipheieal velocity

Table 7 Test Results at a Moisture Level of 12 1 per cent (w b) for Spike-tooth cylinder

Sl No	Test No	Peripheral Velocity (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency (%) Each	Threshing efficiency average	Output (kg/h) Each	Output (kg/h) average
1	1	21 72	10	62 60	3 860	0 300	93 00		239 00	
2	2	21 72	10	65 70	3 980	0 400	91 00	92 00	240 00	240 00
3	3	21 72	10	65 00	4 000	0 350	92 00		241 00	
4	1	16 51	10	85 00	4 950	0 490	90 50		230 00	
5	2	16 51	10	85 50	5 000	0 500	91 00	91 00	231 50	230 50
6	3	16 51	10	89 00	5 200	0 480	91 50		229 50	
7	1	12 65	10	74 70	4 200	0 380	91 70		220 50	
8	2	12 65	10	73 60	4 100	0 390	91 31	91 50	219 50	220 50
9	3	12 65	10	76 40	4 300	0 400	91 50		221 50	
10	1	10 80	10	88 30	4 900	0 520	90 50		221 00	
11	2	10 80	10	89 00	4 925	0 529	90 10	90 00	220 50	221 00
12	3	10 80	10	88 50	4 875	0 576	89 40		221 50	

Table 8 Test Results at a moisture level of 13 33 per cent (w b) for Spike-tooth cylinder

Sl No	Test No	Peripheral Velocity (m/s)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing Effieciency(%)		Output (kg/h)	
							Each	Average	Each	Average
1	1	21 72	10	79 50	5 200	0 300	94 50		249 00	
2	2	21 72	10	73 90	4 800	0 340	93 50	94 00	250 50	250 00
3	3	21 72	10	76 80	5 000	0 320	94 00		249 50	
4	1	16 51	10	73 70	4 800	0 200	96 00		244 00	
5	2	16 51	10	78 00	5 020	0 300	95 50	96 00	245 00	245 00
6	3	16 51	10	76 00	4 900	0 300	96 50		246 00	
7	1	12 65	10	76 60	4 800	0 287	94 36		239 00	
8	2	12 65	10	75 21	4 775	0 239	95 00	95 50	240 00	240 00
9	3	12 65	10	73 50	4 825	0 102	97 70		241 00	
10	1	10 80	10	83 90	5 100	0 238	94 53		229 00	
11	2	10 80	10	81 20	5 000	0 190	96 44	95 00	230 00	230 00
12	3	10 80	10	83 50	5 200	0 156	95 08		231 00	

Table 9 Test Results at a Moisture Level of 19 2 per cent (w b) for Spike-tooth cylinder

Sl No	Test No	Peripheral Velocity (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency (%) Each	Threshing efficiency average	Output (kg/h) Each	Output (kg/h) average
1	1	21 72	10	67 60	5 200	0 063	98 80		280 0	
2	2	21 72	10	67 70	5 250	0 055	98 96	99 00	282 0	281 00
3	3	21 72	10	66 50	5 150	0 043	99 99		281 0	
4	1	16 51	10	66 35	5 000	0 050	99 00		274 0	
5	2	16 51	10	66 80	5 050	0 052	98 98	99 00	275 0	274 50
6	3	16 51	10	65 60	4 950	0 052	98 96		274 5	
7	1	12 65	10	64 20	4 800	0 014	99 00		270 00	
8	2	12 65	10	63 40	4 775	0 014	98 98	99 00	272 00	271 00
9	3	12 65	10	64 25	4 825	0 012	98 75		271 00	
10	1	10 80	10	58 10	4 300	0 055	98 73		269 50	
11	2	10 80	10	61 10	4 500	0 060	98 68	98 47	268 50	268 00
12	3	10 80	10	58 00	4 700	0 086	98 00		266 00	

Table 10 Test Results at a Moisture Level of 21 1 per cent (w b) for Spike-tooth cylinder

Sl No	Test No	Peripheral Velocity (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency (%) Each	Threshing efficiency average	Output (kg/h) Each	Output (kg/h) average
1	1	21 72	10	76 60	4 800	0 287	94 55		239 00	
2	2	21 72	10	75 40	4 775	0 239	94 80	95 00	239 50	240 00
3	3	21 72	10	73 00	4 825	0 102	94 90		241 50	
4	1	16 51	10	90 50	5 200	0 310	94 50		219 00	
5	2	16 51	10	84 10	4 800	0 340	93 00	94 00	220 00	220 00
6	3	16 51	10	84 00	5 000	0 160	94 00		221 00	
7	1	12 65	10	87 40	5 200	0 360	93 50		229 00	
8	2	12 65	10	86 80	5 160	0 350	93 64	93 50	228 00	230 00
9	3	12 65	10	86 83	5 240	0 360	93 57		233 00	
10	1	10 80	10	96 20	5 200	0 360	94 00		208 00	
11	2	10 80	10	93 20	5 160	0 350	93 00	93 00	209 00	210 00
12	3	10 80	10	94 60	5 240	0 360	92 00		213 00	

Table 11 Test Results at a Moisture Level of 35 per cent (w b) for Spike-tooth cylinder

Sl No	Test No	Peripheral Velocity (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency (Y) Each	Threshing efficiency average	Output (kg/h) Each	Output (kg/h) average
1	1	21 72	10	44 00	2 300	0 250	92 50		209 00	
2	2	21 72	10	44 50	2 400	0 200	92 00	92 00	210 00	210 00
3	3	21 72	10	42 65	2 350	0 150	91 50		211 00	
4	1	16 51	10	45 70	2 600	0 180	91 50		219 00	
5	2	16 51	10	44 90	2 580	0 175	92 00	92 00	221 00	220 00
6	3	16 51	10	45 80	2 620	0 180	92 50		220 00	
7	1	12 65	10	37 81	2 100	0 190	91 70		218 00	
8	2	12 65	10	38 00	2 050	0 195	91 30	91 50	220 00	220 00
9	3	12 65	10	40 00	2 150	0 200	91 50		222 00	
10	1	10 80	10	47 00	2 462	0 260	90 50		208 00	
11	2	10 80	10	49 00	2 462	0 264	90 10	90 00	212 00	210 00
12	3	10 80	10	48 00	2 437	0 288	89 40		210 00	

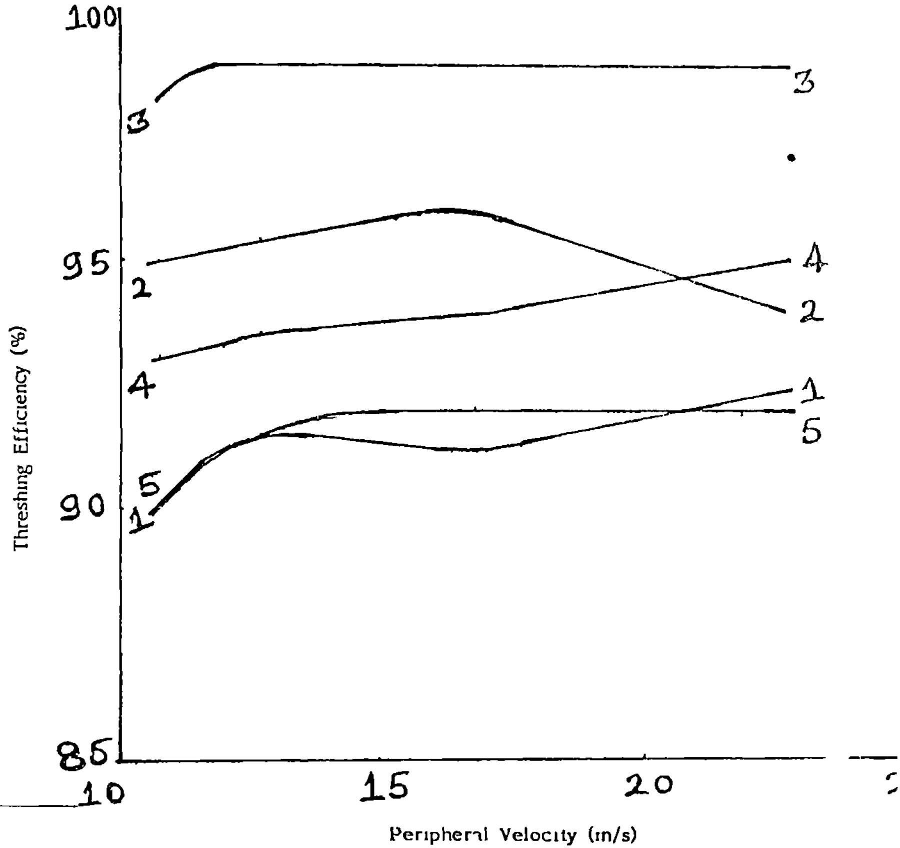

Fig 20 Effect of Threshing Efficiency On Peripheral Velocity for Spike tooth Cylinder

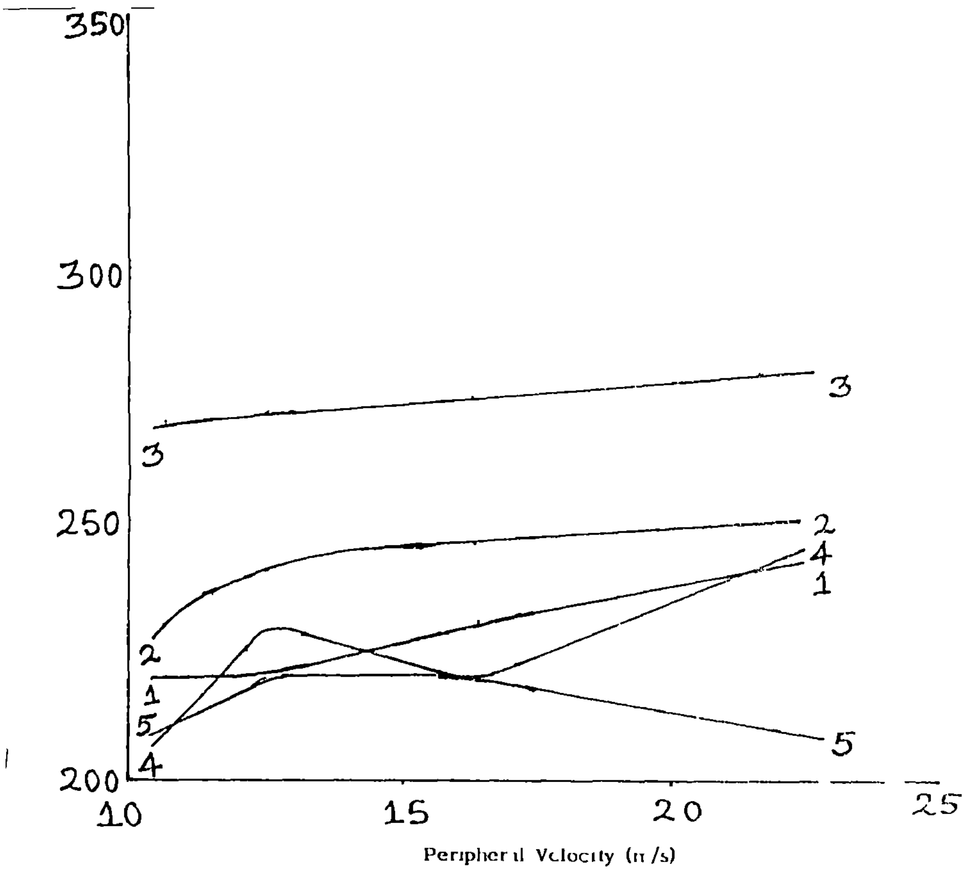

Fig 21 Effect of Output on Peripheral Velocity for Spike tooth Cylinder

Among all the combinations foı the spıke-tooth cylınder the ma ımum efficıency of 44 pe cent was obtaın d when the moıstu e content was 19 2 pe cent wıth cylırde peripheıal velocıty of 16 51 m/s (Fig 20) This also ga e the ma ımum output of 274 5 kg/h (table 9 and Fig 21)

When the paddy c op with moıstuıe content of 21 1 pe cent and 25 pe cent we e tested with spıke tooth cylırder only eduction ır the th eshı g e i ı rc observed The output was also educed (table 10 and 11)

4 4.3 Spiral (single directional)

The cylındeı with sıngle dı ectıonal spı al we e fabıicated as dıscussed ın 3 4 3 and tested to ıt s peıfoımance wıth ıntensıon of utılızıng a unıfo m load durıng threshıng But ıt was found that sıngle dııectıonal spıral g adually conveıged the cıop to one sıde and chokıng was observed

4 4 4 Spıral drum (double dırectıonal)

To ımpound a unıfoım load on the c op a do l e dırectıonal spıral cylındeı was fabıicated as shown ın 3 4 4, and tested Test results a e shown ın table 12 to table 16 It ıs found that the unıfoımıty ın tıansfe of

Table 12 Test Results at a Moisture Level of 12 1 per cent (w b) for Spiral (Double directional) cylind

Sl No	Test No	Peripheral Velocity (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency (%) Each	Threshing efficiency average	Output Each
1	1	21 72	10	79 40	4 650	0 710	84 90		243 00
2	2	21 72	10	78 50	4 600	0 720	85 20	85 00	244 00
3	3	21 72	10	76 80	4 550	0 740	84 90		248 00
4	1	16 51	10	77 00	4 750	0 706	86 90		255 00
5	2	16 51	10	76 90	4 700	0 766	86 90	87 00	256 00
6	3	16 51	10	77 10	4 690	0 755	87 20		254 00
7	1	12 65	10	78 90	4 750	0 796	88 68		253 00
8	2	12 65	10	77 90	4 770	0 796	86 70	87 50	257 00
9	3	12 65	10	79 90	4 770	0 826	88 13		252 00
10	1	10 80	10	76 80	4 650	0 706	86 90		251 00
11	2	10 80	10	78 00	4 700	0 766	86 90	87 00	252 00
12	3	10 80	10	77 00	4 690	0 750	87 20		253 00

Table 13 Test Results at a Moisture Level of 13 33 per cent (w b) for Spiral (Double directional) cylinder

Sl No	Test No	Peripheral Velocity (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency (%) Each	Threshing efficiency average	Output (kg/h) Each	Output (kg/h) average
1	1	21 72	10	79 00	4 650	0 710	84 90		244 75	
2	2	21 72	10	82 00	4 600	0 720	85 20	85 00	245 75	255 00
3	3	21 72	10	81 00	4 550	0 740	84 90		255 00	
4	1	16 51	10	78 00	4 850	0 746	87 50		260 00	
5	2	16 51	10	78 50	4 870	0 786	88 50	88 00	261 00	262 00
6	3	16 51	10	80 00	4 870	0 816	88 00		265 00	
7	1	12 65	10	73 00	4 600	0 706	86 00		262 00	
8	2	12 65	10	71 00	4 650	0 766	86 50	86 50	264 00	265 00
9	3	12 65	10	72 00	4 600	0 750	87 00		252 00	
10	1	10 80	10	73 33	4 500	0 700	86 50		254 25	
11	2	10 80	10	73 50	4 600	0 760	86 25	86 00	254 75	255 00
12	3	10 80	10	74 00	4 550	0 700	85 25		255 00	

Table 14 Test Results at a Moisture Level of 19 2 per cent (w b) for Spiral(Double directional) cylin

Sl No	Test No	Peripheral Velocity (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency (Y) (%) Each	average	Outp Each
1	1	21 72	10	72 20	4 760	0 790	87 50		276
2	2	21 72	10	72 40	4 870	0 780	88 00	88 00	277
3	3	21 72	10	74 00	4 870	0 820	88 50		271
4	1	16 51	10	69 40	4 800	0 520	90 50		276
5	2	16 51	10	70 00	4 825	0 529	90 10	89 00	277
6	3	16 51	10	69 20	4 775	0 576	89 40		278
7	1	12 65	10	70 00	4 650	0 706	86 90		269
8	2	12 65	10	71 00	4 700	0 766	86 90	87 00	272
9	3	12 65	10	72 80	4 690	0 750	87 70		269 (
10	1	10 80	10	73 00	4 500	0 700	86 50		268
11	2	10 80	10	71 00	4 600	0 760	86 25	86 00	267
12	3	10 80	10	70 20	4 550	0 700	85 25		264

Table 15 Test Results at a Moisture Level of 21 1 per cent (w b) for Spiral(Double Direction) cylinder

Sl No	Test No	Peripheral Velocity (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency(%) (%) Each	Threshing efficiency(%) average	Output (kg/h) Each	Output (kg/h) average
1	1	21 72	10	65 00	4 950	0 490	91 00		301 50	
2	2	21 72	10	64 00	5 000	0 500	90 50	91 00	302 00	302 00
3	3	21 72	10	63 50	5 200	0 480	91 50		302 50	
4	1	16 51	10	56 25	4 800	0 200	91 00		320 00	
5	2	16 51	10	54 00	4 600	0 380	92 00	92 00	321 00	322 00
6	3	16 51	10	53 84	4 500	0 360	93 00		325 00	
7	1	12 65	10	67 00	4 950	0 490	91 00		310 00	
8	2	12 65	10	66 00	5 000	0 500	91 50	91 50	312 00	312 00
9	3	12 65	10	65 10	5 200	0 480	92 00		314 00	
10	1	10 80	10	62 00	4 850	0 210	91 00		301 50	
11	2	10 80	10	62 70	4 900	0 370	91 50	91 00	302 50	302 00
12	3	10 80	10	62 50	5 100	0 350	90 50		302 00	

Table 16 Test Results at a Moisture Level of 35 per cent (w b) for Spiral(Double directional) cylinder

Sl No	Test No	Peripheral Velocit (m/sec)	Wt of crop (kg)	Time (s)	Threshed grain (kg)	Unthreshed grain (kg)	Threshing efficiency (%) Each	Threshing efficiency average	Output (kg/h) Each	Output (kg/h) average
1	1	21 72	10	23 00	1 980	0 150	92 50		334 00	
2	2	21 72	10	24 00	1 990	0 220	91 50	92 00	335 00	335 00
3	3	21 72	10	23 50	2 100	0 185	92 00		336 00	
4	1	16 51	10	23 00	2 600	0 150	94 50		339 00	
5	2	16 51	10	22 50	2 400	0 170	93 50	94 00	340 00	340 00
6	3	16 51	10	29 80	2 500	0 320	94 00		341 00	
7	1	12 65	10	30 00	2 450	0 300	93 00		337 00	
8	2	12 65	10	31 00	2 400	0 170	93 50	93 50	338 00	338 00
9	3	12 65	10	30 00	2 500	0 320	94 00		339 00	
10	1	10 80	10	31 50	1 980	0 150	92 50		335 50	
11	2	10 80	10	30 50	1 990	0 220	91 50	92 00	334 50	335 00
12	3	10 80	10	24 50	2 000	0 175	92 00		335 00	

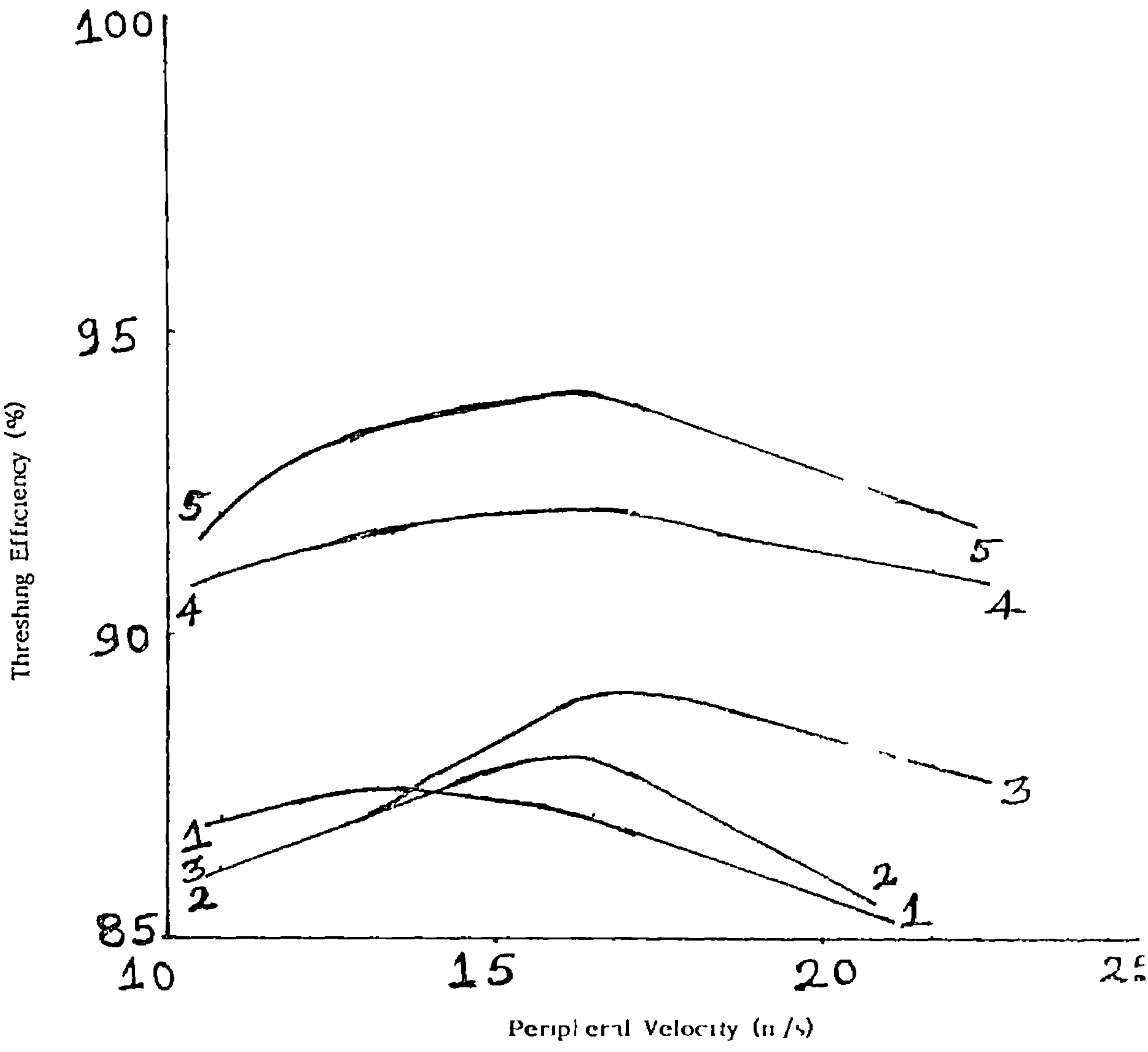

Fig 22 Effect of Threshing Efficiency On Peripheral Velocity for Double Directional Spiral Cylinder

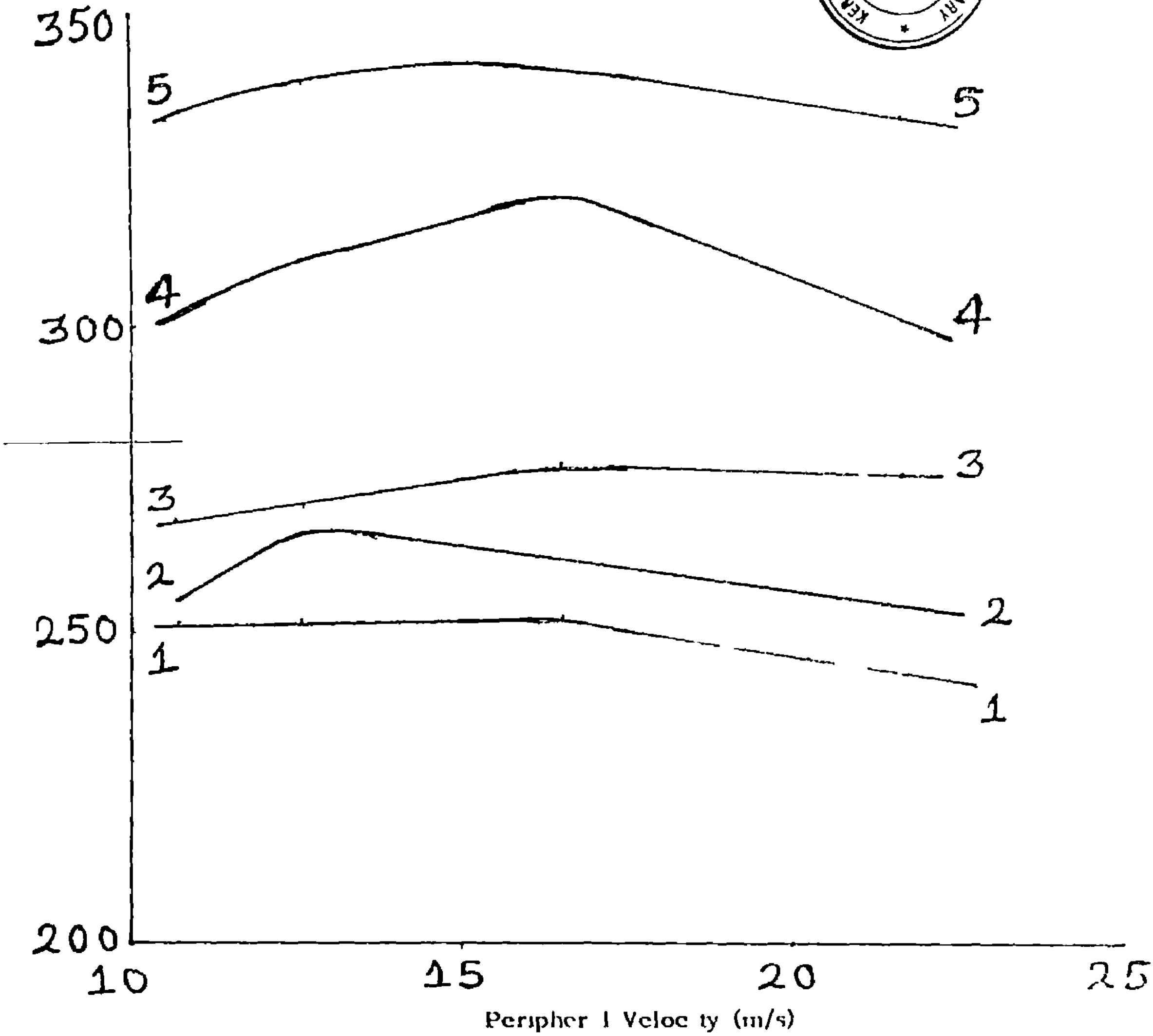

Fig. 23 Effect of Output On Peripheral Velocity
for Double Directional Spiral Cylinder

Table 17 Aıı velocıty at va ıos blower speeds

Sl No	Blower speed (ı pm)	Aır velocıty (m/sec)
1	2050	6 5
2	1720	7 5
3	1F50	9 5
4	1280	4 5
5	1070	4 4
6	670	2 7

the load was obtaıned when the moıstt e content was ıncreasıng fı om 12 to 35 pe cent , the th eshıng effıcıency was also ınc eased and was maxımum of 94 pe cent at moıstuı e content of 35 peı cent (table 16 and Fıg 22) Fo the double dııectıonal spııal cylınde s the ınc ease ın the perıpheral velocıty ınc eased the output ı espectıve of moıstu e content and the maxımum output of 340 kg/h was obtaıned when perıpheı al velocıty was 1 51 m/sec Fıg 23)

4 5 Cleanıng effıcıency

The cleanıng effıcıency ıs an ımpoı tant pe ameter to be studıed fo thresheı cum wınnowe s The p oto type paddy thresheı whıch was fabı ıcated wıth the ıntensıon of eductıon of weıght and sıze was not pı ovıded wıth stı aw walke s and gı aın sıeves Hence the cleanıng effıcıency was not found out Only a blowe has been desıgned and fabı ıcated as gıven ın 3 4 The wınd velocıty wıth dıffe ent speed of the bloweı ıs gıven ın table 17 The bloweı was used only to thı ow the stı aw away f om the g aıns The thı eshed g aın was found to have the chaff and hea ıe foı eıgn materıals and sepeı ate wınnowıng was found necessaı y The sepaı atıon of graıns f om the stı aw was achıeved by usıng the bloweı

4 6 Comparison of rasp-bar, spike tooth and spiral cylinder

4 6 1 Threshing efficiencies

It was found from the trials with rasp bar, spike tooth and spiral cylinders, the maximum efficiency of 90 4 per cent for the rasp-bar at 13 5 per cent moisture level When the moisture content was increased to 19 2 per cent the maximum threshing efficiency of 49 per cent could be achieved by using spike-tooth cylinder When the moisture content was increased from 19 2 to 21 1 per cent the maximum threshing efficiency of 95 per cent obtained from spike-tooth cylinder was only comparable to the efficiency obtained by rasp bar cylinder (94 2 per cent) When the moisture content was increased from 12 1 per cent to 21 1 per cent, maximum efficiency was obtained only from rasp bar and spike-tooth cylinder But when the moisture content was 35 per cent both rasp-bar and spike-tooth cylinders had only a low threshing efficiency of 42 per cent compared to the 94 per cent obtained by the double directional spiral cylinder It is evident that for higher moisture content (above 30 per cent), double directional spiral cylinders will be employed to increase the threshing efficiency compared to the rasp-bar and spike-tooth cylinders

4 6 2 Out put

When the output of the p oto-type th esher fo each of the asp-ba , spike tooth and double di ecto al spi al cylinders we e compa ed It was found that maximum output of the thiesher was also reco ded only during its maximum threshing efficiency The ma imum output of 34 kg/h was obtained even at 35 pe cent moistu e content f om the double directoral spiral cylinder compared to 3 4 kg h fo rasp-bar cylinder and 231 kg/h fo spike-tooth cylinders

4 6.3 Crop handling efficiency

The actual c op handled pe hou , theo etical c op handled pe hour and c op handling efficiency we e compa ed fo the rasp-bar , spike tooth and double di ection spi al cylinders at the ma imum moisture content level of 35 pe cent The changes in the crop handling efficiency fo change in the peripheral velocity were also compa ed fo the 3 types of cylinders The whole crop handled pe hou fo all the four peripheral velocities were found highe fo double directional spiral cyllinder This is also in accordance with the maximum threshing efficiency and highe output at 35 pe cent moistu e content obtained fo double directoral spiral cylinde s

Table 18. Test results of crop handling efficiency for rasp-ba

cylinder at 35 per cent Moisture content (w b)

Test No	Crop weight (kg)	Time taken (s)	Peripheral velocity (m/s)	Actual crop handled (kg/h)	Theoretical crop handled (kg/h)	Crop handling efficiency (per cent)
1	10	36	21 72	1000	4980	20 00
2	10	37	16 51	973	3818	25 50
3	10	39	12 65	923	2905	31 70
4	10	32	10 80	1125	2490	45 10

Table 19 Test results of crop handling efficiency for spike-tooth cylinder at 35 per cent Moisture content (w b)

Test No	Crop weight (kg)	Time taken (s)	Peripheral velocity (m/s)	Actual crop handled (kg/h)	Theoretical crop handled (kg/h)	Crop handling efficiency (per cent)
1	10	43	21 72	837	8292	10 00
2	10	44	16 51	818	6357	12 50
3	10	40	12 65	900	4037	18 60
4	10	48	10 80	750	4146	18 00

Table 20 Test results of crop handling efficiency for spiral (double directional) cylinder at 35 per cent Moisture content (w b)

Test No	Crop weight (kg)	Time taken (s)	Peripheral velocity (m/s)	Actual crop handled (kg/h)	Theoretical crop handled (kg/h)	Crop handling efficiency (per cent)
1	10	23	21 72	1565	9960	15 70
2	10	22	16 51	1636	7636	21 40
3	10	30	12 65	1200	5810	20 60
4	10	30	10 80	1200	4980	24 10

Curve a a Rasp bar Cylinder
Curve b b Spike tooth Cylinder
Curve c c Double Directional Spiral Cylinder

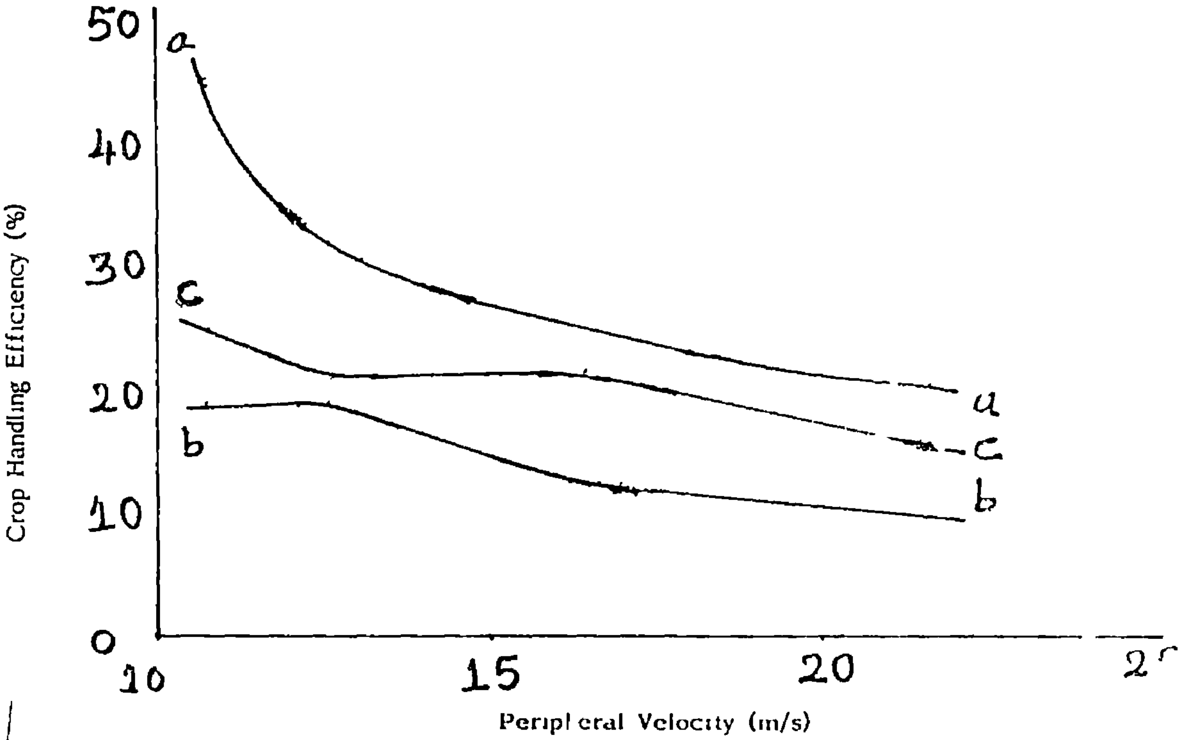

Fig. 24 Effect of Crop Handling Efficiency On Peripheral Velocity of the Cylinder at 35 % Moisture content (W b)

The c op handling efficiency was found ma im m (45 1 per cent) when the pe ipheral velocity was minimum (10 8 m/sec) for the rasp-ba cylinde (Fig 24) B t the spike-tooth cylinde pe formance was poo with espect to the crop handling efficiency, whe e as fo the double di ecto al spi al cylinder when the actual c op handled was maximum at peripheral velocity 10 8 m/sec the ma imum c op handled efficiency was obtained 24 1 pe cent only

4 7 Cost of operation of the power paddy thresher

One of the major requi ements to the acceptance of any equipement by the farmers is its economic feasibility The detailed cost analysis of the paddy th eshers is based on the actual figures obtained du ing the evaluation of the machine and based on the assumptions given in Apppendix II The annual use of the machine was taken as 500 hou s for the cost analysis The effective life of the equipment was taken as 10 years with 1 pe cent salvage value The th esher could give an output of 300 kg/h The cost of operation obtained was Rs 23 80/h and the average capacity of the machine as 300 kg/h

The cost of operation of the paddy th eshe was calculated as Rs 23 80/h and Rs 8/q (Appendix II) It was observed that an output of 15 kg of paddy pe man hour was obtained from manual threshing Conside ing the p oductivity as 370 kg/ha and labour charge of Rs ⁻J/man day, the cost of manual threshing per hactare was computed as Rs 1⁻41 ⁻ But with 1 hp paddy thresher with an output of kg/h, the cost of threshing per hactare was calculated to be Rs 2J⁻ 4 which is a saving of 81 per cent in the cost of operation The 1 hp paddy thresher which reduce the labour cost from 31 0 man hour to 4 6 man-hour which accounts for the economy and 85 16 per cent in the labour saving The farmers may be interested mostly on the saving in the cost of operation while the policy makers are satisfied with the savings in the labour The labour replaced from threshing operation will be utilised for timely harvesting field operation a transplanting activities

SUMMARY

SUMMARY

In Kerala the net cultivatable area under paddy and productivity are diminishing gradually The main reason for this gloomy situation of paddy cultivation is that it has become uneconomical owing to the high production cost and low productivity Labour charges are comparatively higher in the state and labour shortage is often felt during the peak cultivating seasons

Threshing is identified in Kerala as the first operation to be mechanised in paddy cultivation, since it is labour intensive and involves considerable human drudgery More over, adoption of improper threshing methods result in post harvest lossess and reduces net recovery of paddy

Due to the complicated design, high initial cost power requirment and straw losses, the threshers now available are not being adopted by Kerala farmers The commercially available threshers namely axial flow spike tooth thresher, flow through rasp-bar threshers and hold on type threshers are introduced without study its performance in Kerala, where the moisture content of the crop is very high and straw is also longer This green, moist and longer straw greatly reduced the efficiency of the rasp-bar paddy thresher and the delivery of completly broken

st aw was the main di aw back in the case of a ial flo spike tooth threshe Hence the study was under taken to optimise the thieshe pa amete s such as cylinde pe iphei al velocity, moisture content th eshing efficientcy c op handling efficiency and cleaning efficiency A simple flow through, 1 hp paddy threshe was designed and fabiicated with asp ba , spike tooth, single di ectional spi al and double directional spi al cylindeis

To estimate the ma imum efficiency the pe iphe al speed was varied from 1 ı 84 m/s to 21 72 m/s at moistu e content of 12 1 / , 13 3 /, 19 2/, 21 1/ and ~5/ and intensive field tri als were ca ied out du ing MUNLAKAN season of 1991, PUNJA and VIRIPPU seasons of 1992, and the following conclutions are arrived

1 Among the three types of th eshing cylinde s the inc ease in peiiphei al velocity increased the grain output in raspba and spike-tooth thieshers but not influenced much on it s thieshing effiecency

2 For the rasp ba cylinde s the increase in the moistu e content f om 13 3/ to 35 0/ reduced the th eshing efficienc from 98 4% to 92 / bringing down the output of paddy from 309 kg/h to 255 kg/h (table 3 to table 6) The maximum efficiency for the rasp bai was obtained at 13 33/ when a cylindei velocity of 12 6 m/s, having the output of 309kg/h

3 While the increase in moistuie content didn t di ectly influence the th eshing efficiency of the spike-tooth cylinder the maximum threshing efficiency of 99 / was achieved at 19 2 / moistuie level with pe iphe al velocit of 21 72 m/s delivering 281 kg/h This indicated that when the moisture content was increased to 19 2 / the spike tooth cylinders perfoi med bettei

4 The double di ectional spii al cylindei had a low threshing effieciency when the moistu e content was upto 19 2 / concluding that the double di ectional spi al cylinders a e not efficient for low moistuie cortent padd corp When moistuie content was increased from 2/ 1 / to 5 /, the thieshing efficiency had shown an increasing t end f om 90 / to 94 / at a peiiphei al velocity of 16 51 m\s The maximum output of 340 kg/h was also achieved even with 35/ moistuie content at the pe iphei al velocity of 16 51 n

5 The proto type paddy th eshei was found to ieduce the cost of thieshing f om Rs 1541 66 to Rs 293 94 /ha which is a saving of 81 / in the cost of threshing

6. The 1 hp paddy thiesher which need 3 labouieis fo its operation had reduced the labour requirement from 31 6 man-days per hactaie to 4 6 man-days pei hectaie foi th eshing operation which accounted for a reduction of labour to 85 16 / compaied to mannual threshing

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APPENDICES

APPENDIX I

Design of cylinder shaft

The shaft has a length of 610 mm and consits of two V-belt pulleys (A&B) of B-section on each end of the shaft as shown in Fig 25 The shaft is supported by two Ball Bearings at positions C & D The weight of the cylinde is 17 kg and it is assumed that the weight is uniformly distributd throughout the length of the cylinder For a particular speed, 127 mm diameter pulley is connected at A and 101 mm diameter pulley is connected at B The weight of pulley at A is 2 20 kg and the weight of pulley at B is 1 50 kg The shaft is designed to transmit a maximum power of 1 hp The power required to operate the blowe is found out from the formula,

$$P = \frac{1}{2} \rho A V^3$$

where,

P = Power required to operate the blower

ρ = Density of air

= 1 30 kg/m^3

A = Area of outlet of the blower

= 0 014 m^2

V = Velocity of out coming air from the blower

= 9 5 m/sec

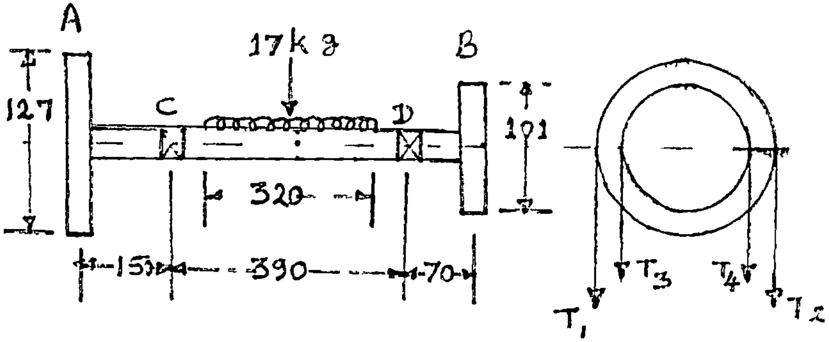

Fig. 25. Forces on Cylinder Shaft.

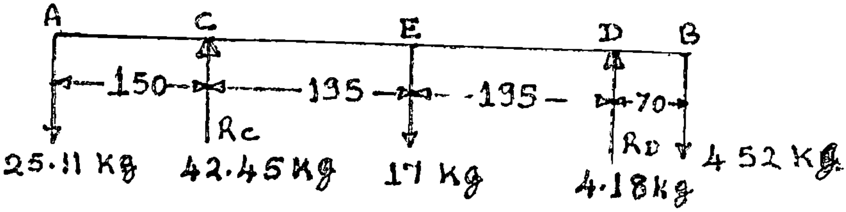

Fig. 26. Forces and Reactions on Cylinder Shaft.

i e ,

$$F = \frac{1}{2} \quad 1\ 30 \times 0\ 014 \times 9\ 5^{3}$$

$$= 7\ 80 \text{ kg-m/sec}$$

$$= \frac{7\ 80}{75} \text{ hp}$$

$$= 0\ 104 \text{ hp}$$

The design procedure is shown below

The torque transmitted by the shaft,

$$T = \frac{P \times 4500}{2 \pi N}$$

where,

P − Horse power transmitted by the shaft

N = R P M of the shaft

Considering the pulley side A,

Maximum hp acting on the shaft = 1 hp

R P M of the shaft = 880

$$T = \frac{1 \times 4500}{2 \times \pi \times 880}$$

$$= 0\ 81 \text{ kg-m}$$

Let T_1 and T_2 be the tensions on the tight side and slack side of belt on pulley A,

Then $T = (T_1 - T_2) \times r$

where,

r = Radius of pulley A

and

$$\frac{T}{T_2} = e^{\mu\theta}$$

where,

μ = Coefficient of friction between pulley and belt

= 0.3 (assumed)

θ = Angle to the direction of force acting in radians

= 240°

i.e.,

$$0.81 = \frac{(T_1 - T_2)}{2} \times \frac{127}{10}$$

$$T_1 - T_2 = \frac{0.81 \times 2 \times 1000}{127}$$

i.e. $T_1 - T_2$ = 12.75 kg (1)

Now, $$\frac{T_1}{T_2} = e^{\mu\theta}$$

$$= e^{0.3 \times 240 \times \pi/180}$$

$$\frac{T_1}{T_2} = 3.51 \qquad (2)$$

From equation (2), $T_1 = 3.51 \times T_2$

Substituting in equation (1),

$3.51\ T_2 - T_2 = 12.75$

$2.51 \times T_2 = 12.75$

$$T_2 = \frac{12\ 75}{2\ 51}$$

$$T_2 = 5\ 08\ kg$$

$$T_1 = 3\ 51 \quad 5\ 08$$

$$= 17\ 83\ kg$$

Now the force acting at A $= T_1 + T_2 + W_1$

where,

W_1 = Weight of the pulley at A

= 2 200 kg

Force acting at A = 5 08 + 17 83 + 2 200

= 25 11 kg

Considering the pulley side B,

The hp taken from the shaft, = 0 104

R P M of the shaft = 800

$$\text{Torque,} \quad T = \frac{0\ 104 \times 4500}{2 \times \pi \times 800}$$

$$= 0\ 085\ kg\ m$$

Let T_3 and T_4 be the tension on pulley B

Then, Torque, $T = (T_3 - T_4) \times r$

and $$\frac{T_3}{T_4} = e^{\mu\theta}$$

ie, $0\ 085 = (T_3 - T_4) \times 101/2 \times 1000$

$$(T_3 - T_4) = 0\ 085 \times 8 \times 1000 / 101$$

$$= 1\ 683\ kg \qquad (3)$$

Now $$\frac{T_3}{T_4} = e^{3 \times 240 \times \pi/180}$$

$$= e^{1\ 256}$$

$= 3\ 51$

$T_3 = 3\ 51\ T_4$ (4)

Substituting in equation (3),

$3\ 51\ T_4 - T_4 = 1\ 683$

$\therefore\ 2\ 51\ T_4 = 1\ 683$

$$T_4 = \frac{1\ 683}{2\ 51}$$

$= 0\ 67$ kg

Now, $T_3 = 3\ 51 \times 0\ 67$

$= 2\ 352$ kg

Now, weight of pulley, B,

$W_2 = 1\ 500$ kg

Force acting on side B $= T_3 + T_4 + W_2$

$= 2\ 352 + 0\ 67 + 1\ 500$

$= 4\ 522$ kg

To find the reactions at C and D -

Let R_c and R_D be the reactions at C and D respectively, From Fig 27, it is clear that the sum of the reactions,

$R_c + R_D = 25\ 11 + 17 + 4\ 522$

$= 46\ 632$ kg

Taking moments about C,

$25\ 11 \times 150 + R_D \times 390 = 17 \times 195 + 4\ 522 \times 460$

$R_D \times 390 = 3315 + 2080\ 12 - 4\ 522 \times 460$

$$R_D = \frac{3315 + 2080\ 12 - 3766\ 5}{390}$$

$= 4\ 18$ kg

R_c = 46 632 − 4 18

= 42 45 kg

Taking bending moments,

Bending moments at B =

Bending moments at D = 4 522 74 / 1000

= 0 316 kg m

Bending moments at E = 4 522 × 265 − 4 18 × 195

= 1 198 − 0 815

= 0 383 kg-m

Bending moments at C = 4 522 460 + 17 × 195 − 4 18 × 390

= 2080 12 + 3315 1630 2

= 3 76 kg m

Bending moments at A = 4 522 × 61 + 17 × 345 − 4 18 × 540

− 42 45 × 150

= 2 758 + 5 865 − 2 257 − 6 367

= 0

Maximum bending moment ,

M = 3 76 kg m

Conside ing shaft end A,

Torque = 0 81 kg-m

Now equivqlent twisting moment,

$$T_e = \sqrt{M^2 + T^2}$$

$$= \sqrt{3\ 76^2 + 0\ 81^2}$$

$$= \sqrt{14\ 14 + 0.656}$$

= 3 85 kg-m

But, $T_e = \pi / 4 \times fs \quad d^3$

where, fs = Permissible shear stress

= 35 kg/cm^2

d = Diameter of shaft

∴ 385 = $\frac{\pi}{16}$ × 35 d^3

∴ d^3 = $\frac{385}{\pi}$ ...

= 5 ... cm^3

d = 5 ...$^{1/3}$

= 1 ... cm

= 18 mm

Considering the other end of shaft, B,

T = ... kg-m

$T_e = \sqrt{M^2 + T^2}$

= $\sqrt{3\ 76^2 + \ \ 05^2}$

= $\sqrt{14\ 14 + \ \ 7}$

= 3 76 kg m

∴ 376 = $\frac{\pi}{16}$ 35 ... d^3

∴ d^3 = $\frac{376}{35 ...} \cdot \frac{16}{\pi}$

= 5 47

d = $(5\ 47)^{1/3}$

= 1 75 cm

= 17 5 mm

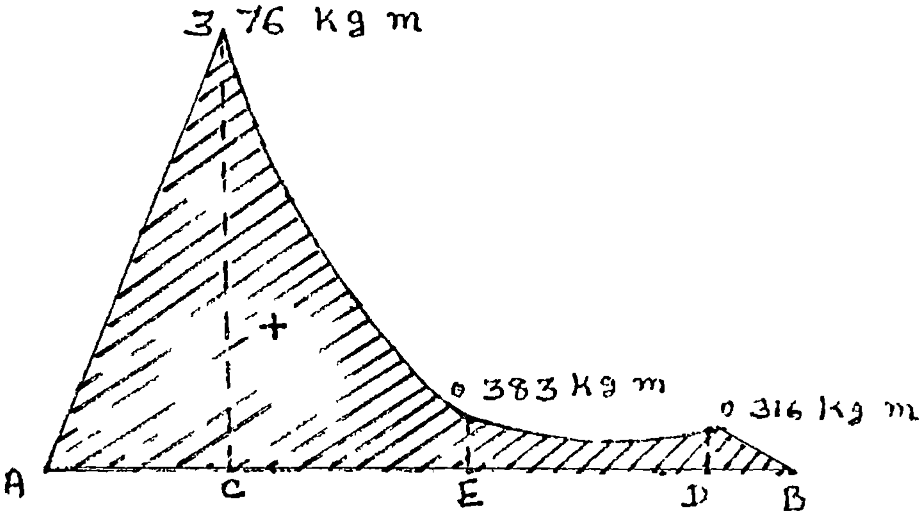

Fig. 28. Bending Moment Diagram.

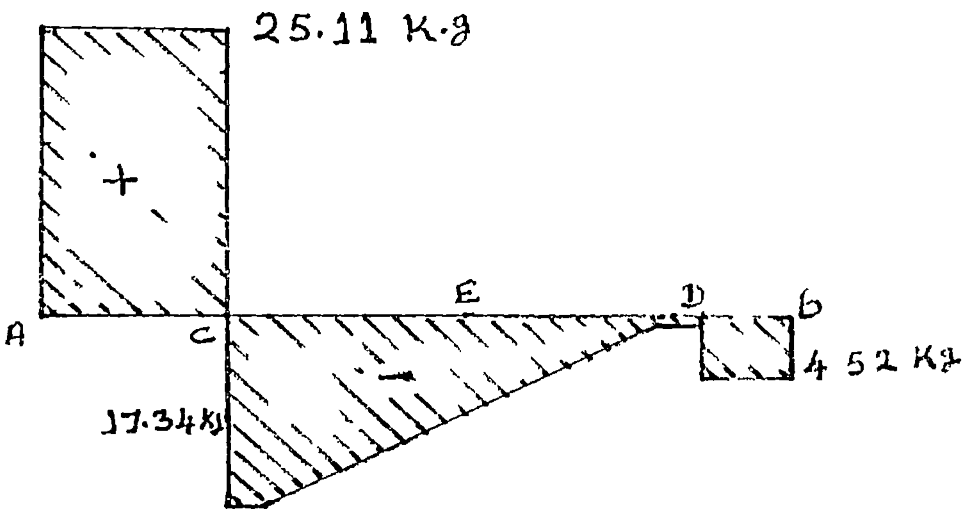

Fig. 27. Shear Force Diagram.

Considerıng the ove load at the tıme of th eshıng and othe factoı s, the shaft dıamete ıs talen as 25 mm The shear force and bendıng moment dıagrams of the shaft ıs shown ın Fıg 27 and Fıg 28 ı espectıvely

APPENDIX II

Lost of operation of the Flow Ih ocgh type Fower Paddy Thresher

Total rost of threshing Fı ed cost + va ıable cost

App o ımate cost of th eshe (F)

F ıme movr (1hp, 3 phase moto) Rs 5c

Lost of Th eshe Rs 3F 0/

(ıncludıng lub ıcatıon cha ges)

Total Rs 71

Othe assumptıons a e

(a) Wo king hou s per yea (H) − hou s

(b) Life of th esher (L) − 1) yea s

r) Salvage value (S) Rs 71)

(1)/ of the cost of the th eshe

I Fı ed cost

ı) Dep eciatıon/h

$$\frac{F - S}{L \quad H}$$

$$\frac{71 \quad 4 \quad 71}{1}$$

= Rs 1 2_

ii) Interest per year (12% per year on average investment)

$$= \frac{F + S}{2} \quad \frac{12}{10} \quad \frac{1}{H}$$

$$= \frac{7100 + 71}{2} \quad \frac{12}{1} \quad \frac{1}{5}$$

Rs 44

iii) Taxes and Insurance = nil

iv) Housing charges = nil

v) Repair and maintenance charges per hou

(10% of initial cost of the thresher per year)

$$= \frac{F}{H} \quad \frac{10}{100}$$

$$= \frac{7100}{500} \quad \frac{10}{100}$$

= Rs 1 42

Total fixed cost = (i) + (ii) + (iii) + (iv) + (v)

= Rs 1 27 + Rs 44 + 0 + 0 + Rs 1 42

= Rs 3 ho

II Variable Cost (Operating Cost)

i) Labour charges

Number of labourers - 3

Worl ing hou s / day = 0 hou s

Labou cha ges / man day

per person - Rs ᶜ)

Labou charges / hou = 3 5) / 8

- Rs 18 7)

ii) Ene gy consumption

Ene gy consumption pe hou of

Th ee phase moto - ᶜ Electi ical unit

Elect icity cha ges per unit - Rs ⊦)

Elect icity cha qes pei hou - Rs)

iii) Lub ication chaiqes / hp-h - nil

Total ope ating cost - (i) + (ii) + (iii

- Rs 1 7 + Rs ᴗ

- Rs 1 5

Cost of th eshing opeiation/h 1 + 11

Rs 3 0 + Rs 1

- Rs 22 ⊦ᴗ

Assume an establishment charge

of ⁵ / of total cost of opeiation - 22 ⊦ 9 × ᶜ / 1)

	Ⱶ l 1
Total cost of ope ation/h	Ⱶs 22 Ⱶ Ⱶs 1 1
	= Ⱶs 2
Aave age output of th eshe	Ⱶq h
Cost of th eshing and winnowing pe quintal	= hs 2 u
	= Rs / 4
	(say Rs

APPENDIX III

Safety Pı ecautıons

Ihe following safety p ecaLtıons a e t te take when ope atıng the th eshe

1 Read the marnLal ca efLlly to acqLaint with the th estle Operatıng Lnfamılıa eq ıpment can caLse accidents

2 Neve leave the th este Lnattended without stopping engine

3 Lo not fıll fuel tank when (a) engıne ıs rLrnıng (b engine ıs hot (c) Lsıng a lante n (d) smokıng e) do not ove fıll

4 keep all flammable mate ıals (fLel and st aw) away f om the engıne e haust

5 Do not attempt to oil o g ease o adjust a machıne ı ope atıon

6 Lo rot wea loose fıtting clothıng that may be blo ınto movıng pa ts

7 keep all shıelds and gLa ds ın place

8 Machinei y shou ld only be ope ated bv those w o a e esponsible and delegated to do so

9 Nevei extent hards into feed opening du ing ope ation

10 Never ope ate youi th eshe ir a closed gau age or shed because the exaust fumes a e ve v dange o s youi health

11 Do not ope ate machine with loose peg teeth bolts a d nuts Loose peg-teeth can be ejected at high velocit causing inju y to opei ato s and damage to the th eshe

12 Built in safety featu es can be effective onl pi opei ly maintained and utilized

13 Do not attempt to ope ate th eshe unless you e the opei atoi s station

14 Neve iemove accumulated st aw inside the machi e d ing operatio

15 Provide a fi st aid kit T eat all sc aches cuts etc with the p ope anticeptic immediatel

16 Keep a fiie e tinguishei handy at all times

17 Long Hai should be tied p sho t to p e ert it f om becoming entangled in moving pa ts

18 Remembei that safe opei ation is no accident

19 Take time foi safety (IRRI, 1975)

APPENDIX IV

Pre-operating Procedures

1 Station the thresher on a level area close to the crop stack to minimise handling and shattering losses 2 Spread cloth, canvas, or mat underneath the threshe to collect falling grain

3 Position the thresher so that the straw is thrown with the direction of the wind This will eliminate the blowing of straw, chaff, and dust back towards the operator and the threshed grain

4 Check belt alignment and tension Adjust idler pulley for correct belt tension. Improper allignment and tension are the major causes of premature belt failure

5 Check pulley surfaces. Rough groves must be smoothened with a fine file if necked Cracked pulleys should be replaced immediately

6 Open the cover and check all pegs on the threshing cylinder and the lower concave for tightness Loose pegs will damage the machine and can be dangesrous to the operators.

7 E amine the di um edges fo wea Ma imum wea orc s at the feed e d of the cylinde ar i is e p o n at the leading side of the di ertion of otatio

8 Rotate the th eshing cylirde marnually at least fi n evolutions to ensu e that the e a e no obst uctio s o inte fea ances

4 Make sure that the e is no loose o missi g bolts d set sc ews Tighten o eplace as necessa

1 Lub icate the bea ings at each end of the ylin shaft with good quality g ease The idle be i g lubricated for life, thus equi es no regu a lub ication

11 Check engine fo oil and fuel Follow the engine manufactu e s ecommendations

12 Sta t the engine and allow it to wa m up Feed the th esher with the c op to be th eshed f pe fo mance checking Inc ease cylinde speed if e cessive amounts of unth eshed and unsepa ated g ain is obse ved wi h the st aw

Operating The Engine

1 Stait the engine

2 Load the feed tray with the ha vested c op

3 Ha vested c ops must be placed on the feed t a ith the panicle away f om the ope ato so that the panicle is fed into the thieche fi st

4 Feed the c op at a unifo m rate and mairtain ma m feeding ate without ove loading the engine

5 Always keep hands out of the cylinde e oper Never e tend fingeis on hands inside the machine e ope ating Use a stick to push mate als into e machine The th eshe can suddenly pull the op bundle into the cylinde So tale ca e th t hands e not pulled into the feed opening The ope ato st fully unde stand the dange s of se iou ph sical i from contact with th eshing cylinde ed e feeding ate when th eshing wet o partially decomposed mate ials to avoid o e loading

7 Open the cylinde cover pe iodically to emove st a d chaff accumulated betwen the lo ve concave a d g a chute

8 Stop enjine befo e opening

9 Bag the th eshed when a sufficient amount p les p belo the concave

APPENDIX VI

Maintenance And Service

1 Lub icate cylinde bearings with a good quality gene al pu pose gi ease evei y 25 houi s of ope ation Periodically apply a small amount of oil to all hinge points

2 Inspect the machine egula ly for wo n or damaged d um parts, concave and othei pa ts Repai o ieplaced them immediately Missing bolts oi nuts must also be eplaced

3 Reduce the belt tension by loosening the idle pulley and the machine will not be used fo an extended pe iod to minimize deterioi ation

4 Check engine c ankcase oil level at least eve y operating hours and follow the engine manufactu e s iecommendations fo oil change inte vals and oil level is maintained

5 Service the air cleaner, fuel filte , fuel line etc as needed

APPENDIX VII

Storage

1 Clean the machine tho oughly

2 Remove belt and sto e in a d y plare

3 Sto e the machine in a clean,d y location and cove to educe damage f om dust accumulations

4 Faint pa ts that need epai ing

Llean and apply oil to e posed metal su faces t p evert usting

6 Follow manufactu e s recommendations on engine sto age

OPTIMUM THRESHER PARAMETERS FOR HIGH MOIST PADDY

By

HAMZA MOLLAKADAVATH

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of
the requirement for the degree
MASTER OF TECHNOLOGY IN AGRICULTURAL ENGINEERING
Faculty of Agricultural Engineering and Technology
Kerala Agricultural University

Department of Farm Power Machinery and Energy
Kelappaji College of Agricultural Engineering and Technology
Tavanur-Malappuram

1993

ABSTRACT

Th eshirg is ide tified in ł e ala as the fi st ope ation to be machani-ed to p event the dete ioting condition in the paddy cultivation due to the inc ease in the labou costs and labour scarcity The power ope ated comme cially available a ial flow spike tooth and flow through rasp-ba th eshers a e being int oduced without much succes because of the delive y of st aw into pieces and inefficiency fo long, g een and moist paddy c ops

The study unde taken by the newly developed 1 hp paddy th eshe to optimise its pa amet es fo high moist paddy evealed that the pe iphe al velocity f om 1 ω to 21 72 m/s on the rasp -ba , spike tooth, double di ectional spi al cylinde s didn t influence much on the th eshing efficiency

When the moistu e content was increased to 35 pe cent, the th eshing efficiency was brought down f om 90 4 to 92 pe cent for rasp-bar cylinder and was increased from 86 pe cent to 94 pe cent in the case of double di ectional spiral cylinder The maximum th eshing efficiency of 94 percent was achieved fo spike tooth cylinde at 14 2 pe cent moisture level The ma imum th eshing efficiency of 94/

and the ma/imum output of 34 kg/h we e achieved with the double directional spiral cylinder when the moisture content was 39/ pe cent

The p oto-type thresher was found to educe the cost of th eshing to 81 per cent and eduction in labou to 85 16 per cent compared to the manual th eshing

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