PERFORMANCE EVALUATION OF MANUAL DRAWN ENGINE OPERATED SOYBEAN HARVESTER

PROJECT REPORT

Submitted to

College of Agricultural Engineering and Technology,

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

In partial fulfilment of the requirements

for the Degree of

BACHELOR OF TECHNOLOGY

In

Agricultural Engineering

By

SAGAR RAJESHRAO DUDHE

ABHAY SATISHRAO WATH

UNDER THE GUIDANCE OF

DR. A. V. GAJAKOS

DEPARTMENT OF FARM POWER AND MACHINERY,
COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
Dr. PANJABRAO DESHMUKH KRISHI VIDYAPEETH,
AKOLA (M.S) 444104

Enrolment Number- RR-15 & RR-59 **June 2023**

PERFORMANCE EVALUATION OF MANUAL DRAWN ENGINE OPERATED SOYBEAN HARVESTER

PROJECT REPORT

Submitted to

College of Agricultural Engineering and Technology,

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

In partial fulfilment of the requirements

for the Degree of

BACHELOR OF TECHNOLOGY

In

Agricultural Engineering

By

SAGAR RAJESHRAO DUDHE (RR-15)

ABHAY SATISHRAO WATH (RR-59)

Approved By

PROJECT GUIDE	**: Dr. A. V. GAJAKOS**	**: _____**
HEAD OF DEPARTMENT	**: Dr. S. H. THAKARE**	**: _____**
ASSOCIATE DEAN	**: Dr. S. B. WADATKAR**	**: _____**

DEPARTMENT OF FARM POWER AND MACHINERY,
COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
Dr. PANJABRAO DESHMUKH KRISHI VIDYAPEETH,
AKOLA (M.S) 444104

2022-23

DECLARATION OF STUDENT

We hereby declare that the experimental work and its interpretation in the project report entitled **"PERFORMANCE EVALUATION OF MANUAL DRAWN ENGINE OPERATED SOYBEAN HARVESTER"** or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis publication of any University or scientific organization. The source of materials used and all assistance received during the course of investigation have been acknowledged**.**

Place: Akola

Date: / /2023

SAGAR RAJESHRAO DUDHE
(Enroll No RR-15)

ABHAY SATISHRAO WATH
(Enroll No RR-59)

CERTIFICATE

This is to certify that the project report entitled **"PERFORMANCE EVALUATION OF MANUAL DRAWN ENGINE OPERATED SOYBEAN HARVESTER"** submitted in partial fulfillment of the requirement for the degree **of "Bachelor of Technology (Agricultural Engineering)"** of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **SAGAR RAJESHRAO DUDHE AND ABHAY SATISHRAO WATH** under my guidance and supervision.

The subject of the project has been approved by the project guide.

Place: Akola
Date: / /2023

Dr. A. V. GAJAKOS
Associate Professor
Department of FPM
Dr. PDKV, Akola

Countersigned

Dr. S. B. WADATKAR
Associate Dean
College of Agricultural Engineering & Technology
Dr. PDKV, Akola

ACKNOWLEDGEMENT

Success is not possible lonely without involvement of many minds and hands to beautify it. Emotion cannot be adequately expressed in words because then emotions are transformed into mere formalities. Nevertheless, formalities have to be completed. My acknowledgements are many more than what expressing here.

We feel immense pleasure we taking golden opportunity of expressing our sincere, humble indebtedness sense of gratitude from core of our heart towards our respected guide, **Dr. A. V. Gajakos**, Associate Professor, Department of FPM & PI, FMTTC, Dr. PDKV, Akola for his scholastic guidance, valuable suggestion keen abiding interest, constant inspiration and constructive criticism. His friendly guidance and encourage sustain one all along and helped us greatly in studies and project work. His valuable consistent efforts and strives to keep the progress of work genuine by providing the necessary facilities throughout the research not only in our project work but will prove as light house throughout our future life. No words are adequate to express our thanks to him.

We are equally indebted to the **Dr. S. H. Thakare**, Head, Department FPM, Dr. PDKV, Akola, **Dr. S. K. Thakare**, Professor(CAS), **Dr. M. M. Deshmukh**, Associate Professor and Senior Scientist, AICRP on FIM, **Dr. A. K. Kamble**, Assistant Professor, and **Dr. D. S. Karale** Assistant Professor, Department of FPM, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. For their valuable guidance and suggestion during the course the research work.

We express our deep sense of gratitude to **Dr. S. B. Wadatkar**, Dean, Faculty of Agricultural Engineering, Dr. PDKV, Akola, for the kind help of the administration during our degree program and for providing all the necessities of the present research work. We are also thankful to **Mr. Rajesh Gajbhiye, Mr. Vinod Ambhore, Mr. Gopal Tak** for their help in completion of this project.

No words or phrase can convey our exact feeling to our parents for their pathetic efforts, scarifies, encouragements in educating us at the cost of their comfort and consolation. We wish to express our heartful, cordial, sincere and inherent thanks to our friends, our batch mates during carrying out this experimentation and untiring help rendered with cheerful smiling gestures.

Above all, we bow our head before the God. Almighty for providing us beloved parents, loving brother and sister, bosom friends and many well-wishers.

Place: Akola
Date: / /2023

SAGAR RAJESHRAO DUDHE
(Enroll No RR-15)

ABHAY SATISHRAO WATH
(Enroll No RR-59)

Table of Contents

A) List of Tables

B) List of Plates

C) List of Abbreviation

Abbreviation		Expanded Form
A	-	Area
Avg	-	Average
cm	-	Centimeter
Dr. PDKV	-	Dr. Panjabrao Deshmukh Krishi Vidyapeeth
EFC	-	Effective field capacity
et al.	-	And others
etc.	-	Etcetera
FC	-	Field capacity
FE	-	Field efficiency
g/cm^3	-	Gram per cubic meter
g/kg	-	Gram per kilogram
gm	-	Gram
ha	-	Hectare
ha/h	-	Hectare per hour
hp	-	Horse power
h	-	Hour
i.e.,	-	That is
kg	-	Kilogram
kg/ha	-	Kilogram per hectare
km	-	Kilometer
km/h	-	Kilometer per hour
L	-	Liter
l/h	-	Liter per hectare
m	-	Meter

m^2	-	Square meter
MC	-	Moisture content
min	-	Min
mm	-	Millimeter
No.	-	Number
^{o}	-	Degree
Rpm	-	Revolution per minute
Rs	-	Rupees
Rs/ha	-	Rupees per hectare
s	-	Second
SOPA	-	Soybean Processor Association of India
Sr. No.	-	Serial number
TFC	-	Theoretical field capacity
T_l	-	Non-productive time
T_p	-	Productive time
W	-	Width
W_{hl}	-	Harvesting losses
W_{st}	-	Shattering losses
W_{uc}	-	Uncut losses

D) Abstract

a)	**Title of the thesis**	**:**	**PERFORMANCE EVALUATION OF MANUAL DRAWN ENGINE OPERATED SOYBEAN HARVESTER**
b)	**Full name of students**	**:**	**1) Sagar Rajeshrao Dudhe** **2) Abhay Satishrao Wath**
c)	**Name and address of Major Advisor**	**:**	**Dr. A. V. Gajakos** Associate Professor Department of Farm Power and Machinery, Dr. PDKV, Akola.
d)	**Degree to be awarded**	**:**	B. Tech (Agril. Engg.)
e)	**Year of award of degree**	**:**	2023
f)	**Total number of pages in the thesis**	**:**	52
g)	**Number of words in the abstract**	**:**	143
h)	**Signature of the students**	**:**	
i)	**Signature, name and Address of forwarding authority**	**:**	

Head
Department of Farm Power & Machinery, Dr. PDKV, Akola

ABSTRACT

The performance evaluation of manual drawn engine operated soybean harvester was carried out for harvesting of soybean crop at of Highway Block, Central Research Station, Dr. PDKV, Akola.

Cost analysis of mechanical harvesting of soybean crop by developed manual drawn engine operated soybean harvester were compared with the cost for manual harvesting to determine the benefits of mechanical harvesting over manual harvesting.

The effective field capacity and field efficiency of the manual drawn engine operated soybean harvester were found to be 0.149 ha/h and 86.6% respectively. Fuel consumption of manual drawn engine operated soybean harvester was 0.46 l/h. The average harvesting losses in mechanical harvesting was 18.71%. The cost of operation of manual drawn engine operated soybean harvester and manual harvesting were 888 Rs/ha and 3000 Rs/ha respectively. In mechanical harvesting the percent saving in cost of operation were found to be 70%.

CHAPTER I

INTRODUCTION

Agricultural mechanization embraces the use of tools, implements, and machines for a wide range of farm operations from land preparation to planting, harvesting, on-farm processing, storage, and marketing of products. Sources of farm power include hand tools, draft animals, and mechanically- powered technologies. Agricultural mechanization often follows various stages, starting from the use of mechanical power for power-intensive operations that require little control (such as milling, threshing, water pumping. or land preparation) followed by control-intensive operations (such as harvesting, weeding, and adapting farming systems and cropping patterns) to increased use of mechanically powered technologies, and finally to automation of production. Development of mechanization systems involves the appropriate and systematic selection of power sources, equipment and /or implements that perform the given operations with optimal use of resources (finance, time, inputs) and minimum human labour bringing viability to farm operations. A significantly higher proportion of soybean farms are still manually harvested. There is need to develop mechanization systems for soybean harvesting that meet the above definition.

Soybean is one of the main oil seeds produced in India. It is now second largest oilseed crop in India after groundnut However, Soybean production has faced harvesting challenges especially among the medium scale famers who are poorly mechanized. This group of farmers cannot viably use human labor or buy combine harvesters to accomplish the harvesting operations. This has seen most of the soybean crop getting lost through shattering or affected by rains because of late harvesting. This is against the economic and nutritional importance of the seed. The seed contains about 20% oil and 34-36% protein which makes it an economically important seed. It is grown for

processing into edible oil and the residue from oil extraction is a high protein meal, a critical ingredient for stock feeds. It also consists of 30% carbohydrates, vitamins, minerals and excellent amounts of dietary fiber. (Source-IOSR-JAVS,2013)

The main efforts towards increased food production have been directed towards greater agricultural production through efficient cultivation, using high yielding varieties, fertilizers, insecticides and good crop husbandry. The main problem has been due to lack of understanding of the magnitude of losses which occurs during harvesting.

1.1 Soybean production in world

In the year from 2017-18 to 2021-22 soybean production of various countries over the world given in following table 1.1 (In million metric tons)

Table 1.1: Soybean production in world

Year	US	Brazil	Argentina	China	India
2021-2022	119.884	144	52	19	11.2
2020-2021	112.549	137	47	19.6	10.45
2019-2020	96.667	128.5	48.8	18.1	9.3
2018-2019	120.515	119.7	55.3	15.967	10.93
2017-2018	120.065	123.4	37.8	15.283	8.35

Source: The Soybean Processors Association of India,2023

1.2 Soybean production in India

As seen in the above table India stands at the fifth position as far as soybean production at world level is concerned. Soybean is the most important oilseed crop of India. Besides contributing significantly to the edible oil pool, it earns considerable amount of foreign exchange for the country. Within four decades of its introduction to central and

southern parts of the country, it has made significant inroads among agrarian community. (Source-Vision 2030-Directorate of Soybean Research, Indore)

Soybean has become an important oilseed crop in India in a very short period with approximately 10-million ha area under its cultivation. India is divided into five agro-climatic zones for soybean cultivation. These are northern hill zone, northern plain zone, north eastern zone, central zone, and southern zone. There are specific varieties released for each zone which are suited to their agro-climatic conditions. There has been an unprecedented growth in soybean; area which was just 0.03 m ha in 1970 and has reached to 9.30 million ha in 2010. The mean national productivity has increased from 0.43 t/ha in 1970 to 1.36 t/ha in 2010.

The major soybean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Gujarat and Telangana. Madhya Pradesh accounts for about 45% of the total soybean production in India.

Table 1.2: Soybean production in India (2022)

State	Production (in lakh tonnes)
Madhya Pradesh	55.84
Maharashtra	46.01
Rajasthan	10.62
Karnataka	3.82
Gujarat	2.24
Telangana	1.51

Source: The Soybean Processors Association of India,2023

In spite of the fact the production of soybean is increasing as result of improved methods of farming, the harvesting techniques employed are still primitive. Soybean harvesting is carried out manually in most parts of our country. Harvesting is one of the important operations of farming. This is a labor-intensive seasonal operation consuming about 18-20% of the labour required for growing cereal crops (Singh et al. 2008). The traditional method of harvesting with is both labour as well as time consuming, where both are scarce during the peak harvesting season.

Harvesting essentially means cutting of the plants from ground level with view of recover the desired parts of the plant to meet the food, feed, fuel and fiber requirement of human and animal kingdom. Harvesting is a critical as well as an important operation of all the production processes. It may include gathering, curing, bunding, transporting material to the threshing floor. Timely harvesting is most essential to avoid shattering losses, which has been a serious problem with most of the soybean varieties commonly grown in India. Non availability of labour at the time of harvesting as it coincides with Rabi sowing, it is delayed and shattering losses occurs. Due to shattering problem many of the farmers showed their reluctance to grow soybean in beginning in present procurement system of beans and also introduction of newly developed harvesting machines has encouraged them to grow more and more soybean.

1.3 Soybean farming cultivation

a) Land selection and its preparation

Land selection is very important in soybean farming as this will impact the overall production of soybean. The main land must not have been sown with soybean crop in the previous season to avoid volunteer plants that causes admixture. The soil with high organic matter defiantly helps in leading the production. Primary tillage

operation ploughing is done, after that cultivator is used to break the clouds which make land ready for sowing.

b) Seed treatment

To control seed borne diseases, soybean seeds should be treated with carbendaz in fungicide at 4 g/kg.

c) Sowing

Sowing in soybean farming should be done in lines 45 cm to 60 cm apart with help of seed driller. Plant to plant distance can be kept from 4-5 cm. The sowing depth of soybean seed should not be more than 3-4 cm under ideal moisture condition

d) Manures and fertilizers application

5 tons of well decompose compost (cow dung or farm yard manure (FYM)) is spread along with basal application of 360 kg super phosphate, 40 kg urea and 50 kg muriate of potash per acre.

e) Weed control

Immediately after sowing and watering apply basalin weedicide by dissolving two mi in 1 liter of water. This spraying of weedicide must be done within three days of sowing if done latter, can damage the soybean crop. Spraying of weedicide will control the early growth of weeds to control later emerging weeds in the crop, first hoeing should be carried out after 2 weeks. Then second hoeing is carried out within 30 days and manual weeding is carried out if necessary

f) Pest and disease control

The major pest in soybean farming is heliothis which makes holes in young pods and eat the seeds. Collect the warms and destroy them or spray with Dimethoate Methyl Dematone or Phosphomidan 2 ml/lit of water. Another common disease in soybean farming is powdery

mildew it causes white powder deposits on the leaves. This disease can be controlled by spraying Dethane M 45 at the rate of 4 g/lit of water.

g) Harvesting

The maturity of soybean crop period ranges from 90-145 days depending on the variety used for cultivation. It should be an indication of maturity when the leaves turn yellow and drop and soybean pods dry out very quickly. The moisture content in the seed should be about 15-17 %.

1.3 Importance and need of study

Due to rapid industrialization and large-scale migration to urban areas labour is becoming increasingly scarce. This labor shortage during harvesting resulted in delayed harvest and consequent field losses. Farm mechanization will also result in lesser cost of operation. combine harvester are also used in some parts of country but are faced with limitation of small soybean field and intercropping

Being a dryland region in Vidarbha most of the soybean crop is taken as intercrop with pigeon pea so as to have crop security. In case sole soybean the farmer can adapt combine harvester on custom hiring ranges but in case of intercrop soybean combine harvester cannot be used as the size of combine harvester does not allow its use in intercrop soybean. At present the only option for harvesting of intercrop soybean is manual labour. During peak season of harvesting shortage of manual labour causes the loss of crop due to delayed harvesting & sometimes also damaged due to untimely raining.

To overcome all the problems, it became essential to mechanize the harvesting of soybean crop. Thus, there was a need for a smaller and more efficient harvester which would be considerably cheaper and

more accessible in intercropping. Hence, we attempt the performance evaluation of manual drawn engine operated soybean harvester.

1.4 Objective:

1) To evaluate field performance of manual drawn engine operated soybean harvester for soybean harvesting.

2) To compare the cost of operation of manual drawn engine operated soybean harvester with manual harvesting of soybean crop.

CHAPTER II

REVIEW OF LITERATURE

This chapter is devoted to the review of relevant research work carried out by the investigators. Review of literature provides guidelines in formulating the framework of the study, deciding and method of approach to the problem and analyzing the data collected. It also helps to compare the results of such studies and reasoning for them.

Some of the work relevant to this dissertation published in the farm power and machinery journals, energy journals, periodicals, reports and matter available on internet etc. is presented in this chapter. This literature published having investigation are reviewed in subsequent section.

Performance evaluation of harvesters

A) Fodder harvester

Rangasamy *et al.* (1993) developed a power weed cutter, Performance of the power weed cutter was evaluated and compared with the performance of conventional method of manual weeding by using hand hoe and manual operated dry land weed cutter. The field capacity of the weed cutter was 0.04 ha/h with weeding efficiency 93 percent for the removing weeds. The cost of operation with the power weed cutter amounted to Rs. 250 as against Rs. 490 by dry land weed cutter and Rs.720 by manual weeding. The saving in the cost and the time was 65 percent and 93 percent respectively.

Anonymous (2004) studied on tractor mounted flail type forage harvester cum chopper, it was observed that the machine could harvest and chop the fodder crop to a size of 80 mm. The field capacity, labour requirement and fuel consumption varied between 0.44-0.52 ha/h,

3.84-4.54 man-h/ha and 4-4.5 liter respectively. The cost of operation was observed Rs. 1113/ha.

Vikram Singh and Rana Noor Aalam (2017) studied the 3LD-450S Self-propelled cutter bar type fodder harvester, in this study, performance of Self-propelled cutter bar type fodder harvester used for berseem and Sudan harvesting was assessed and compared with manual harvesting using sickle. The results showed that the actual field capacity of the fodder harvester for berseem was 0.24 ha/h at 2.5km/hr and for sudan it was 0.23ha/hr at 2.5 km/hr. Labor requirements for berseem fodder harvester and manual harvesting were 4 and 13 man-h/ha, respectively and for sudan it was 4 and 13 man-h/ha. For berseem harvesting the fuel consumption, operating speed and field efficiency were 0.35 l/h, 2.5km/h, 80% respectively. For Sudan harvesting the fuel consumption, operating speed and field efficiency were 0.49 l/h, 2.5 km/h, 78.75% respectively. Cost of harvesting for berseem and Sudan was Rs 995.58/ha and Rs 1002.54/ha.

Hafiz Sultan Mahmood et al. (2016) studied the performance evaluation of different fodder cutters. The performance of four types of locally available fodder cutters was evaluated in the field for cutting oats and berseem fodders. These fodder cutters included Agritec rotary mower, Taj rotary mower, Mobi reaper-windrower and AMRI sickle bar. Agritec and Taj rotary mowers were suitable for cutting both berseem and oats. Mobi reaper- windrower and AMRI sickle bar were only suitable for cutting oats and other long fodders. Agritec rotary machine was the best for cutting berseem as well oats. Using fodder cutters, cutting time and cost of operation can be decreased up 70-80 % as compared with manual cutting. For dairy farming, suitable fodder cutters should be promoted in the country for speedy work. However, reliability of machine is the prerequisite for commercialization of a machine.

B) Reaper harvester

Devani R. S. and M. M. Pandey (1985), Designed a tractor mounted vertical conveyer reaper and power tiller for harvesting of wheat and rice. The field capacity for the tractor mounted and power tiller mounted reapers was 0.337 ha/h and 0.269ha/h, respectively. Cost of harvesting by tractor mounted and power tiller mounted Reaper was 20-30 % lower than manual harvesting. The losses were reported to be 4-6 %. However, some of the losses were recoverable type. The labour requirement for machine harvesting was about one third of manual harvesting. Increased field capacity reduced the cost of operation by the reaper.

Singh G., A.P. Chaudhary and D. Gee-Clough (1988), in Pakistan the time required for harvesting wheat by mechanical reapers was less than 50% of that of manual method and harvesting losses due to use of the machine was more than losses due to manual harvesting. The time required for reaping alone by reaper was 6 % of the time taken for manual cutting of crop by sickle.

Alam *et al.* (197 4) found that 1-5 per cent harvesting loss was caused by sickle harvesting 110 days after sowing of soybean, sown in the first week of July and delay of 20 days increased the harvest loss to 8.8 per cent.

Sharma, S.K. and B.L.Madhyan (1985) the harvesting data shows significantly affected the harvest losses. Early harvest reduces the harvest losses as the plant has optimum moisture content and therefore, shattering, bundling and transporting losses get reduced. The study also shows the varietals effect upon the total harvest was found to non-significant, this may be due to the fact that all verities are high yielding and their maturity period is almost same i.e., 120-125 days after sowing.

Bukhari S. A., Q. Mughal and A. N. Mirani (1991), in Pakistan, found that total harvesting losses in wheat due to use of reaper was less than 50% of the loss by sickle harvesting. They also found that the labour requirement for harvesting by reaper was less than 50 % of sickle harvesting.

Singh S., D. K. Vasta and M. K. Verma (2007) have carried out feasibility testing and performance evaluation of power tiller operated reaper in hills of Himachal Pradesh. They observed that the field capacity of the reaper at the university farm at farmers field was 0.14 ha/h and 0.094 ha/h, respectively at the forward speed of 1.78 km/h and 1.35 km/h with field efficiency of 64.22% and 56.62%. The total labour requirement including harvesting, collection, bundle making etc. with the machine was 57.14 man- h/ha and 75.63 man-h/ha at the university farm and farmers field, respectively whereas it was 173.11 man-h/ha with m harvesting losses were recorded as 5.8% at the farm and 11.8% at farmers field, however, no pre-harvesting losses were reported. The capacity of machine at the farm was observed 93% more than the manual harvesting (0.009 ha/h) and saved 35% cost of operation with 2 times labour. The harvesting of the machine at farmer's field was observed 90% more as compared to manual system but harvesting losses was also more. The performance of the machine in big sized plots was observed and it was not found feasible for small and irregular shaped plots of size less than 150 m^2.

Patel *et al.,* (2018) evaluated the performance of the reaper binder for Wheat crop with respect to field capacity, field efficiency, fuel consumption, harvesting losses, labour requirement and cost of operation and compared with manual harvesting method. The effective field capacity and field efficiency of the machine was found to be 0.17 ha h^{-1} and 78.49 per cent at an average operating speed of 2.55 km h^{-1}. The cost of harvesting with reaper binder and manual harvesting was found to be Rs. 3235.11 and Rs. 5550 per hectare respectively. The losses were found to be 25.42 kg ha^{-1}. The observed fuel consumption

was 1.12 L ha^{-1} and the cost of harvesting was low as compared to manual harvesting. The feedback of machine operation was collected by some farmer's at the time of harvesting and the performance of the reaper binder at the farm was satisfactory.

C) Combine harvester

Veerangouda M., Sushilendra and Anantachar (2010) conducted performance evaluation of tractor operated combine harvester as per RNAM and BIS test codes in farmers fields and found that the average value of effective field capacity of the machine was 0.64 to 0.81ha/h with field efficiency of 67.02 to 76.83 percent. The harvesting losses were in the range of 2.88 to 3.60 percent for paddy harvesting. The cost of operation was lesser for tractor operated combine harvester as compared to manual method by 57.65 to 65.55 percent.

Ebrahimi Nik MA *et al.* (2009) studied "optimum utilization of low- capacity combine harvesters in high-yielding wheat farms using multi-criteria decision making and reported that about 23% of wheat farms in Iran have yields of 5more than 5 tons per ha, but the technology and the capacity of over 85% of the existing combine harvesters were low and they were not suitable for handling such high yields mainly because of their high harvest losses due to high feed rates. Several aspects mainly, seed breakage, total harvest losses, fuel consumption, and combine field capacity were considered as harvesting attributes. Nine different combinations of ground speed and effective width were defined as harvesting candidate alternatives. The MCDM technique indicated that simply reducing the effective width is not the most suitable solution for this problem.

Alizadeh and Allameh (2013) conducted field performance of five different harvesting methods and reported that the maximum and minimum effective field capacity were for whole-crop combine (0.361hah-1) and hand cutting (0.009hah-1) respectively. Total harvesting losses were 5.07% for rice reaper + threshing by universal

combine harvester equipped with pick up type header (T3) (maximum) and 2.74% for head-feed rice combine (T4) (minimum)

Dogra B., Dogra R. and Mahal JS. (2011) conducted comparative grain losses using conventional and axial flow combine harvesters for paddy and reported that there was approximately 0.5% lower processing losses and 1% lower broken grains in axial flow combine harvesters as compared to conventional combine harvesters. Particularly broken grains were reduced by 2.5 to 5 times Axial flow combine harvesters should be promoted for harvesting paddy to reduce grain losses during combine harvesting.

Junsiri and Chinsuwan (2009) studied to predict header losses of a combine harvester and the result of the study indicated that grain moisture content (M), reel index (RI), cutter bar speed (V), service life of cutter bar (Y), tine spacing (R), tine clearance over cutter bar (C), stem length (H). product of M and Y. product of M and V, product of RI and R, product of V and C, product of V and H.V2 and R12 were significant. The prediction equations hadR2 = 0.75. The average percentage header losses given by the estimation equation differed from the measurement by only 0.25.

Rob Proulx (2023) stated that field studies in soybean harvesting have shown that a 10% or higher harvest loss is not uncommon. He further stated that harvest loss can be reduced to 3% or less. To keep losses low, one must know where harvest losses occur, how to measure loss, what is a reasonable level of loss, and the equipment adjustments and operating practices that will help reduce losses.

CHAPTER III

MATERIAL AND METHODS

This chapter deals with the material used and methods followed in conducting experiment of the proposed study leading to performance evaluation of manual drawn engine operated soybean harvester. This chapter gives idea about different losses occurs during harvesting and specification of plot and manual drawn engine operated soybean harvester used for harvesting.

The present study was conducted in the following sequence.

- Study of crop parameters
- Performance evaluation of the developed manual drawn engine operated soybean harvester.
- Cost estimation for manual drawn engine operated soybean harvester.

3.1 Study of crop parameters

Different varieties of soybean crop are grown in Vidarbha region of the Maharashtra state. The crop parameters are necessary to study before the performance evaluation of any machine. The crop characteristics vary with the variety of crop and play an important role in the development of the machine. The physical characteristics of soybean crop were studied for various observations given below:

a) Height of plant, cm
b) Row to row spacing, cm
c) Plant to plant spacing, cm
d) Minimum pod height from ground surface, cm
e) Stem diameter, cm
f) Plant population, per m^2
g) Crop (grain and stem) moisture content, %
h) Stubble height, cm

Crop parameters

Crop parameters such as row to row spacing, stem diameter, crop height, plant population, minimum pod height from ground surface, stubble height, pre harvest losses and crop (grain and stem) moisture content etc. were measured calculated as discussed below:

3.1.1 Height of plant

Crop height of randomly selected plants in the test field was measured with the help of measuring tape. Average of twenty such readings was taken for analysis.

3.1.2 Plant to plant spacing

Plant to plant spacing was determined by measuring the distance between two consecutive plants of soybean with the help of measuring tape.

3.1.3 Row to row spacing

Row to row spacing was determined by measuring the distance between two consecutive rows of soybean with the help of measuring tape.

3.1.4 Minimum pod height from ground surface

The minimum pod height from ground surface is the distance of first pod from ground surface. It was measured with the help of measuring tape. The average of twenty the readings was taken for analysis.

3.1.5 Stem diameter

Stem diameter of randomly selected soybean plant from the test field was measured by using digital vernier caliper. The average of twenty such plants was taken for analysis.

3.1.6 Plant population

For determination of plant population an area of 1m^2 was marked using white lime powder. The row-to-row distance of soybean was 0.45m hence the area was taken as 1m^2 and plant population was determined by counting no. of plants in 1m^2 area. Four such replications were taken in field and average value was taken for analysis.

3.1.7 Stubble height

To determine the stubble height, height of cut from the ground of randomly selected plants in the test field was measured with the help of a measuring tape and the average value was taken. Stubble height should be less than the minimum pod height from ground surface to reduce the losses.

3.1.8 Moisture content of soybean stem

Moisture content on dry basis of the soybean stem was measured by oven dry method by collecting randomly selected plants from different places in the test field and then putting them in oven for 24 hours at 60 °C. The dry weight of crop plants was determined to calculate the moisture content of the crop plant. It is the ratio of weight of water removed to the weight of dry matter in a given mass of crop, (dry basis) (Sahay et. al., 1994)

$$\boldsymbol{M.C.}(\%) = \frac{\boldsymbol{W_w}}{\boldsymbol{W_d}} \times \mathbf{100}$$

Where,

Ww = Weight of the water removed from the stem sample, gm

Wd = Weight of the dry stem, gm

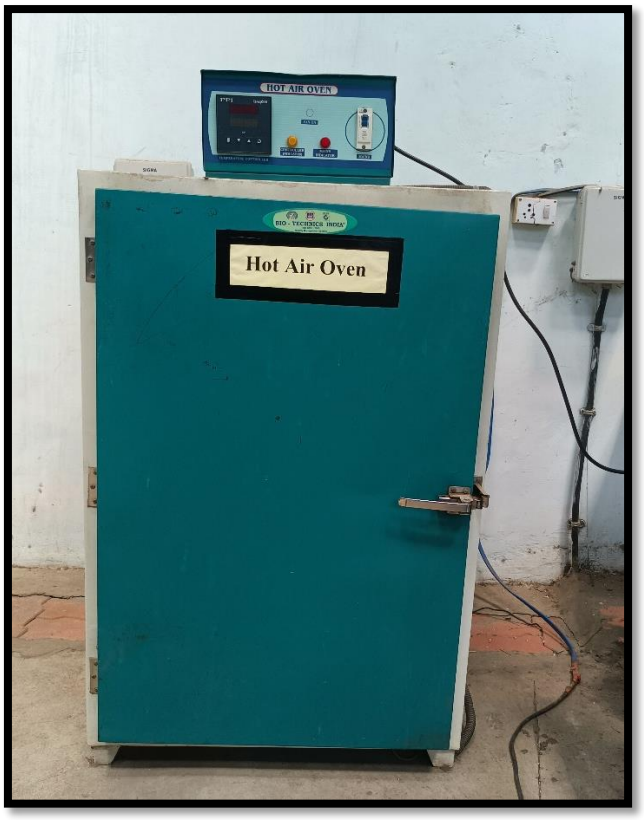

Plate No 3.1: Hot air oven

3.2 Location of test

The performance evaluation of manual drawn engine operated soybean harvester for soybean harvesting was carried out at Highway Block, Central Research Station, Dr. PDKV, Akola in the month of April 2023.

3.3 Constructional details and specification of manual drawn engine operated soybean harvester

The manual drawn engine operated soybean harvester is shown in plate no.3.2, 3.3, 3.4 and specification of manual drawn engine operated soybean harvester are given in table 3.1

Table 3.1: Specification details of manual drawn engine operated soybean harvester

Sr. No.	Specifications	Details
1.	Overall dimensions (LxWxH), cm	140x90x90
2.	Weight, kg	31
3.	Cost of equipment, Rs	24000
4.	Power source	Engine
5.	Fuel used	Petrol
6.	Horse power required, hp	1.5
7.	Rated width, cm	90
8.	Cutter bar pitch, mm	50

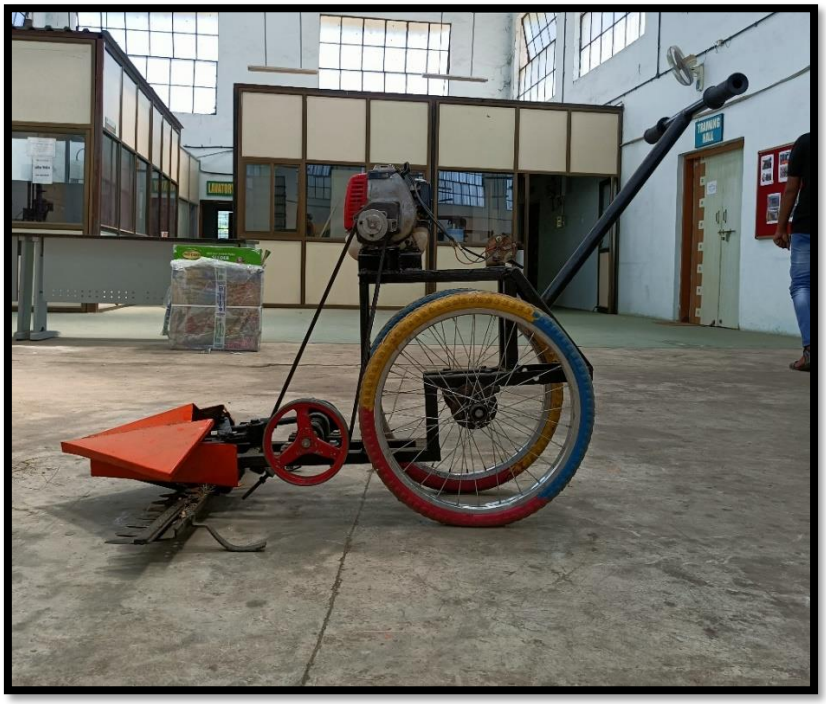

Plate No 3.2: Left side view of manual drawn engine operated soybean harvester

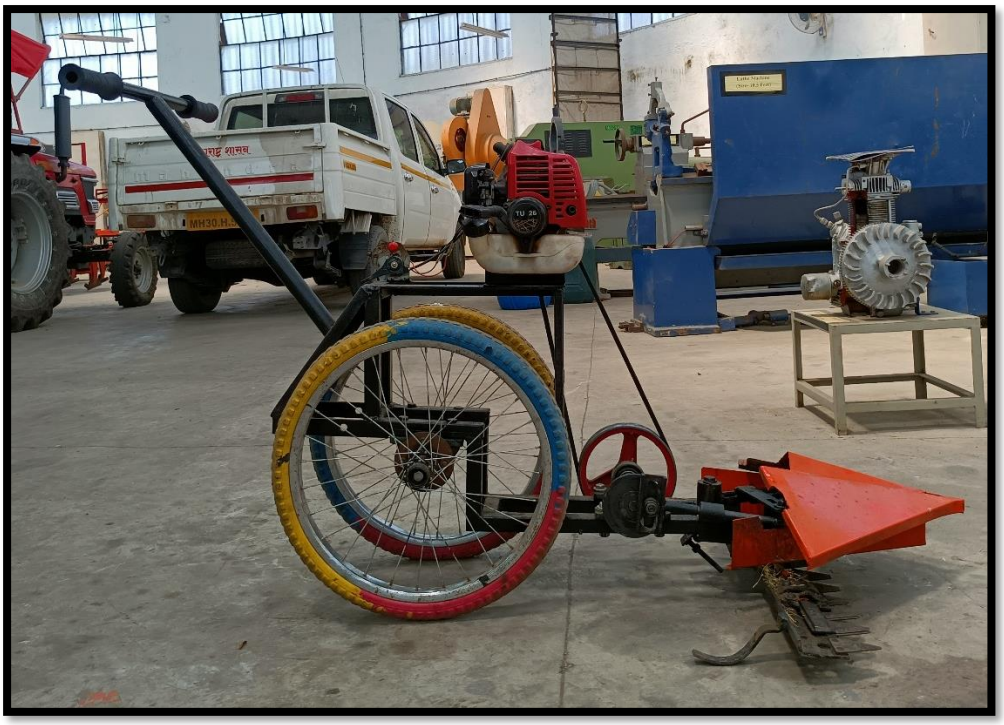

Plate No 3.3: Right side view of manual drawn engine operated soybean harvester

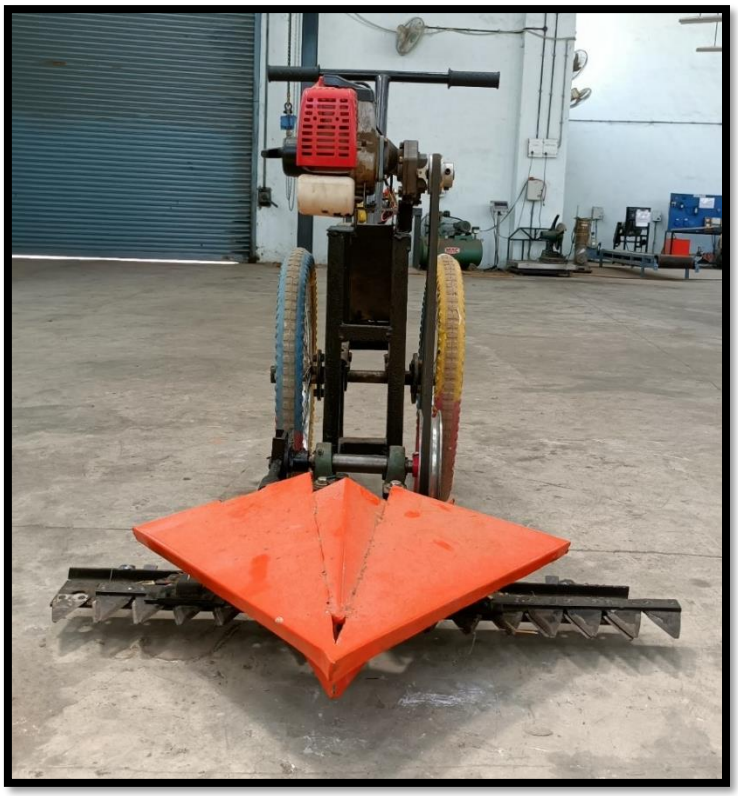

Plate No 3.4: Front view of manual drawn engine operated soybean harvester

3.4 Materials:

3.4.1 Measuring tape

Measuring tape of 5 m and 30 m were used for making and marking the layout of the test plots of 1 m^2 area, it was also used for measuring the specification of manual drawn engine operated soybean harvester.

3.4.2 Lime powder

It was used for marking the test plot

3.4.3 Weight balance

An electronic weight balance of capacity 300 g and of least count 0.01 g was used to measure the weight of grain for determination of harvesting losses and yield of harvested plot.

3.4.4 Polyethylene bags

Polyethylene bags were used for collecting the different sample of grain and stem.

3.4.5 Stop watch

Stop watch, measuring a minimum of one tenth of one second and maximum of 12 hours was used to record the travelled speed and time required to cover the measured area during the test.

3.4.6 Measuring cylinder

The measuring cylinder of capacity 1 liter and of least count of 5 ml was used to measure fuel consumption of manual drawn engine operated soybean harvester.

3.4.7 Digital vernier caliper

The digital vernier caliper is used for measuring the diameter of stem.

3.4.8 Digital grain moisture meter

It was used for measuring the moisture content of different sample of grain.

3.4.8.1 Grain moisture measurement

For determination of the moisture content of grains, a grain sample was collected from the field and the moisture content was measured by using digital moisture meter. Steps to measure the moisture content using this equipment are given as below: -

Press ON ⟶ SELECT ⟶ Product Code ⟶ Pour sample ⟶ Result

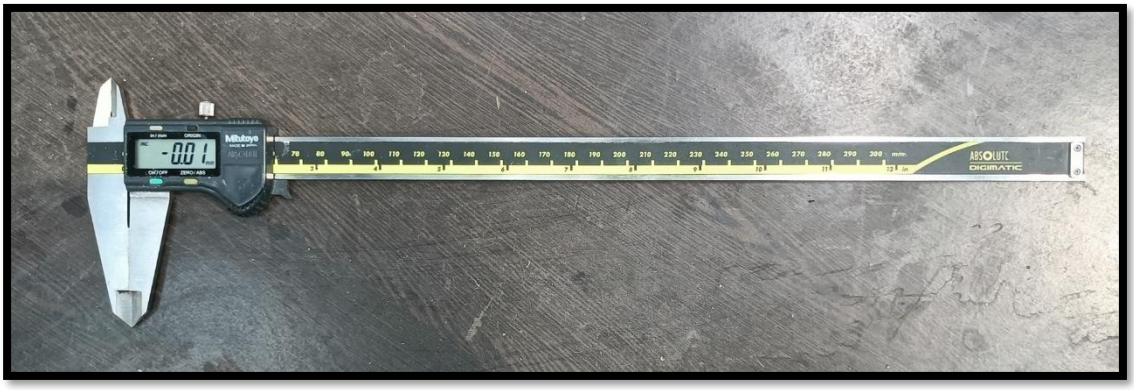

Plate No 3.5: Digital vernier caliper

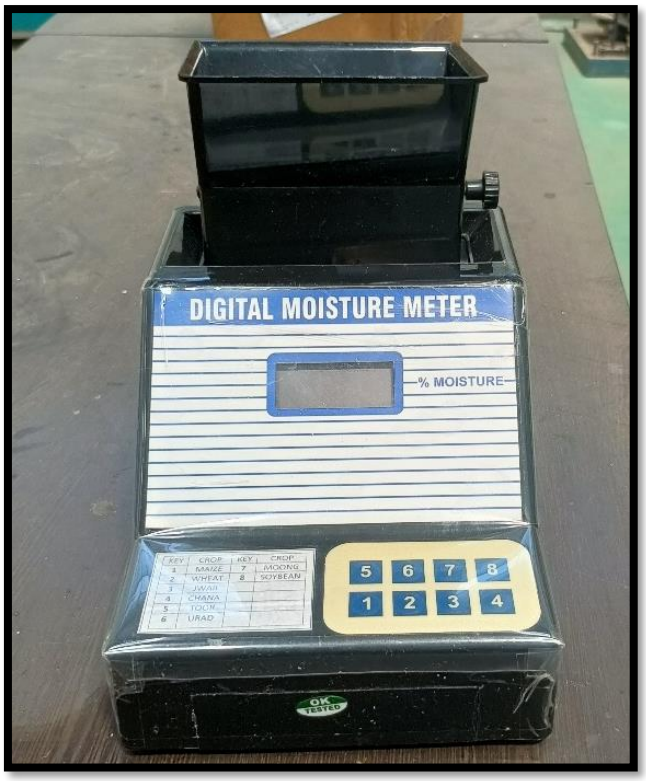

Plate No 3.6: Digital grain moisture meter

3.5 Performance evaluation of manual drawn engine operated soybean harvester

The performance of manual drawn engine operated soybean harvester was evaluated by taking the field tests. The field tests were taken according to procedure described under fallowing sections.

3.5.1 Specification of manual drawn engine operated soybean harvester

The manual drawn engine operated soybean harvester was parked on the firm horizontal ground surface and various dimension of machine were measured.

3.5.2 Field testing of manual drawn engine operated soybean harvester

Field performance tests were carried out to obtain actual data on overall performance of manual drawn engine operated soybean harvester and working capacity in field condition. The performance evaluation of manual drawn engine operated soybean harvester was evaluated in the experimental field. The following parameters were measured during harvesting of soybean crop.

3.5.2.1 Speed of operation (forward speed)

Speed of operation is calculated to determine the other performance characteristics like field capacity and field efficiency during field trial of cutting mechanism speed of operation was measured by recording the time required to cover 20-meter distance by using stopwatch.

The speed of operation of manual drawn engine operated soybean harvester was calculated by using the following formula

$$\text{Speed (km/h)} = \frac{Distance\ Covered\ (m)}{Time\ requried\ to\ cover\ the\ distance\ (\text{sec.})}$$

3.5.2.2 Effective field capacity

For calculating effective field capacity, the time take on for actual work and the loss for other activities such as turning, cleaning, and adjustment of machine and speed time spend for the machine trouble were taken into the consideration.

Effective field capacity was calculated as,

$$\text{Effective field capacity(ha/h)} = \frac{A}{Tp+Tl}$$

Where,

A =area covered, ha

Tp= productive time, hr

Tl= non-productive time, h (time lost for turning, cleaning, adjustment of machine)

3.5.2.3 Theoretical field capacity

It is the rate of field coverage of the machine based on 100 per cent of the time at the rated speed and covering 100 percent of its rated width. It depends upon speed and theoretical width of the machine the theoretical field capacity was calculated as

$$\text{Theoretical field capacity(ha/h)} = \frac{S\ X\ W}{10}$$

Where,

S= speed of travel, km/h

W= theoretical width of machine, m

3.5.2.4 Field efficiency

Field efficiency is the ratio of the effective field capacity and theoretical field capacity and expressed in the percentage. Field efficiency was calculated as

$$\text{Field efficiency (\%)} = \frac{Effective\ field\ Capacity\left(\frac{ha}{h}\right)c}{Theoretical\ field\ capacity\left(\frac{ha}{h}\right)} X100$$

3.5.3 Fuel consumption

To measure the fuel consumption, first manual drawn engine operated soybean harvester was kept on leveled surface. Then fuel tank of manual drawn engine operated soybean harvester was filled up to top of the tank before the test starts. At the end of each test manual drawn engine operated soybean harvester was parked at some leveled

location and then tank was again filled with fuel to maintain the original level of fuel. Quantity of fuel filled in the tank was measured by measuring cylinder. The quantity of fuel required to make up the original level as before the operation was actual fuel consumption.

3.5.4 Harvesting losses

In order to estimate harvesting losses in manual drawn engine operated soybean harvester, first the losses that occur before harvesting (preharvest) collected from selected different plot of 1 m² area. After harvesting shattering and uncut losses are determined by collecting the grain from harvested plot. Harvesting losses include preharvest, shattering and uncut losses.

$$\boldsymbol{W_{gt} = W_{g1} + W_{g2} + W_{g3}}$$

Where,

W_{gt} = Total losses (g/m^2)

W_{g1} = Pre harvest losses (g/m^2)

W_{g2} = Shattering losses (g/m^2)

W_{g3} = Uncut losses (g/m^2)

3.5.5 Shattering losses

It includes the soybean and detached soybean pods that are shattered from stalks by cutter bar of manual drawn engine operated soybean harvester.

3.5.6 Uncut losses

It includes the soybean remaining in uncut pod and plants when the manual drawn engine operated soybean harvester harvests the crop.

3.5.7 Percentage of harvest losses

The percentage of harvest losses are determined by following equation.

$$H=\frac{Whl}{Yg}\times 100$$

Where,

H= percentage of harvest losses (%)

W_{hl}= harvesting losses(g/m^2)

Y_g= grain yield (g/m^2)

3.5.8 Cutting efficiency

Cutting efficiency of the manual drawn engine operated soybean harvester was calculated by following equation.

$$\boldsymbol{Cutting\ efficiency},\% = \frac{\boldsymbol{No.of\ plants\ cut\ per\ m^2}}{\boldsymbol{Total\ no.of\ plants\ per\ m^2}} \times \mathbf{100}$$

3.6 The cost of operation per hour was determine by using straight line method

The total cost of operation per hour consists of fixed & variable operating cost

A. Fixed cost includes

1 Depreciation

2 Interest on the capital

B. Variable operating cost includes

1 Fuel cost
2 Lubrication cost
3 Repair and maintenance cost
4 Wages of operator per hour

C. Total cost = A+B

A) Fixed cost per hour

The fixed cost of manual drawn engine operated soybean harvester was calculated by taking the total of following costs.

1) Depreciation cost

It is loss of value of manual drawn engine operated soybean harvester with passing time. It is calculated by following formula

$$D = \frac{P-S}{LXh}$$

Where,

D= Depreciation per hour
P=Purchase price or capital Investment
S= Salvage value which is 10% of purchase price
L= Total life of machine (year)
h= no. of working hours

2) Interest per hour

Interest is calculated on the investment of the manual drawn engine operated soybean harvester by taking into consideration the value of the manual drawn engine operated soybean harvester in first and last year and was calculated by following formula,

$$I = \frac{P+S}{2} X \frac{R}{100 X h}$$

Where,

I = Interest to be paid per hour
R=Rate of interest per year

B) Variable cost

It include total of following costs

1) Fuel cost

It includes actual cost paid for fuel during operation of manual drawn engine operated soybean harvester.

2) Lubrication cost

Cost for lubrication should be calculated on the actual consumption. For manual drawn engine operated soybean harvester, it is taken as 20% of fuel cost

3) Repair and maintenance cost per hour

Generally, cost of repair and maintenance varies between 5 to 10 % of the initial cost per year. Here, it was 7% of initial cost and calculated as

$$\text{Repair and maintenance cost per hour} = \frac{P\ X\ 7}{100\ X\ h}$$

4) Wages of operator per hour

One skilled labour was required for operating the manual drawn engine operated soybean harvester. Its charge per hour was calculated by considering current labour charges.

C. Total cost (A+B)

Thus finally, Total cost of operation of manual drawn engine operated soybean harvester was calculated in Rs. per hour by adding A and B above.

Total cost = Fixed cost per hour + Variable cost per hour

Determination of cost of operation for manual drawn engine operated soybean harvester in Rs/ha was calculated by using following formula.

$$\text{Cost of Operation (Rs/ha)} = \frac{Cost\ of\ harvester(\frac{Rs}{h})}{Effective\ field\ capacity\ of\ harvester(\frac{ha}{h})}$$

CHAPTER IV
RESULTS AND DISCUSSIONS

The manual drawn engine operated soybean harvester was tested in the field to evaluate its overall performance. In this chapter discussed about the result of performance evaluation tests of manual drawn engine operated soybean harvester for harvesting of soybean crop. The field trials were conducted at the field of Highway Block, Central Research Station, Dr. PDKV, Akola

Beside this, mechanical and traditional method of harvesting was evaluated and cost of operation incurred in both methods was calculated. Percentage saving in cost of operation per hour per hectare over traditional method were also computed. Harvesting losses in the harvesting methods were also measured. The testing was carried out on total area 0.005 ha. The results obtained in the test are discussed and presented in this chapter.

4.1 Crop parameters

Before conducting the experiments, crop conditions of were studied and different relevant parameters were observed in terms of row to row spacing, crop height, stem diameter, plant population, crop moisture content and pre-harvesting loss, etc. The mean values of these different parameters for soybean crop are given in Table 4.1 and 4.2.

4.1.1 Row to row spacing

Row to row spacing was measured by measuring the distance between the two rows of the crop with the help of measuring tape. Sowing of soybean crop was carried out by seed drill and 45 cm row to row spacing was noted.

4.1.2 Plant to plant distance

Plant to plant distance of soybean was measured with the help of measuring tape. The average value of readings from field were taken. For field average value of plant-to-plant distance was found to be 3.6cm.

4.1.3 Crop height

Crop height from ground surface to the tip of the plant of randomly selected plants was measured with the help of measuring tape. The average of twenty such values was taken for analysis. Average crop height in field was found to be 56.62 cm.

4.1.4 Stem diameter

Stem diameter of plant was measured with the help of digital vernier caliper. The diameter at cutting height of twenty randomly selected plants from each field was measured and average value is considered for analysis. Plate 4.1 shows the measurement of stem diameter.

Average stem diameter of the soybean plants was found to be 5.9 mm in field

4.1.5 Minimum pod height from ground surface

The minimum pod height from ground surface of twenty randomly selected soybean plants from field was measured with the help of measuring tape. Minimum pod height of soybean plants was observed to be 3.9 in field. The minimum pod height from ground surface was found to be lesser than the height of cut hence the losses from uncut pods were more.

4.1.6 Plant population

For determination of plant population an area of 1m^2 was marked using white lime powder. The row-to-row distance of soybean crop was 0.45m hence the area was taken as 1m^2 and no. of plants per 40 m^2 was counted. Four replications in field were taken and the average value was taken for analysis.

The average plant population obtained in field was 40 plants per m^2.

4.1.7 Stubble height

To determine the stubble height, height of cut from the ground of randomly selected plants in the test field was measured with the help of a measuring tape and the average value was taken for analysis. Stubble height should be less than the minimum pod height from ground surface to reduce the losses.

The average stubble heights in field were observed to be 9.4 cm which was more than the observed minimum pod height from ground surface.

4.1.8 Stem moisture content

The stem moisture content of soybean crops for at the time of mechanical harvesting was observed to 29.61%.

4.1.9 Plant specification

Some of the agronomical specification measured while harvesting of soybean mechanically are shown in the table 4.1. The values of height of plant, minimum pod height from ground, height of cut were given in the table 4.2

The average height of plant, row spacing of soybean crop in mechanical harvesting was observed to 56.62 cm, 45 cm, respectively. It can be seen that, the minimum height of pod from the ground surface was 3.9 cm only.

Table 4.1: Soybean crop specification

Sr. No.	Parameters	Details
1.	Crop	Soybean
2.	Variety	JS-9305
3.	Location	Highway Block, Central Research Station, Dr. PDKV, Akola
4.	Date of sowing	29/12/2022
5.	Type of soil	Black cotton soil
6.	Soil moisture content, %	13.39
7.	Crop condition	Erect
8.	Average height of crop, cm	56.62
9.	Average stem diameter of crop, cm	0.59
10.	Average pod height from ground, cm	3.9
11.	No. of pods/plant	23
12.	Plant population /(Sq.m)	40
13.	Grain moisture, %	9.8

4.1.10 Grain moisture content

The grain moisture content of soybean crops for at the time of mechanical harvesting from test plot number were observed to 9.8%.

4.1.11 Soil moisture content

The soil moisture content of soybean crops is observed to 13.39 %.

Table 4.2: Different crop parameters of soybean

Sr. No.	Height of plant(cm)	Stem diameter (cm)	Pod height from ground (cm)	No. of pods/plant	Height of cut, (cm)
1	60	0.64	3	14	11
2	51	0.66	3.8	19	11.5
3	49	0.477	3	21	11.8
4	57	0.647	25	23	11
5	52	0.658	3.2	27	9.5
6	63	0.567	2.7	15	9.0
7	59	0.493	2.9	19	8.2
8	56	0.598	3.0	18	8.0
9	60	0.608	1.5	30	8.2
10	53	0.527	2.3	25	9.0
11	50	0.603	3.3	22	9.3
12	61.5	0.652	3.5	21	11.5
13	64	0.681	4.0	20	8.5
14	58	0.553	2.0	26	8.7
15	55	0.642	3.1	18	9.2
16	60	0.702	3.4	22	9.6
17	54	0.509	2.7	24	9.0
18	62	0.487	2.5	32	8.6
19	56	0.503	2.0	31	11.2
20	52	0.643	1.8	24	10.5
avg	**56.62**	**0.59**	**3.9**	**23**	**9.4**

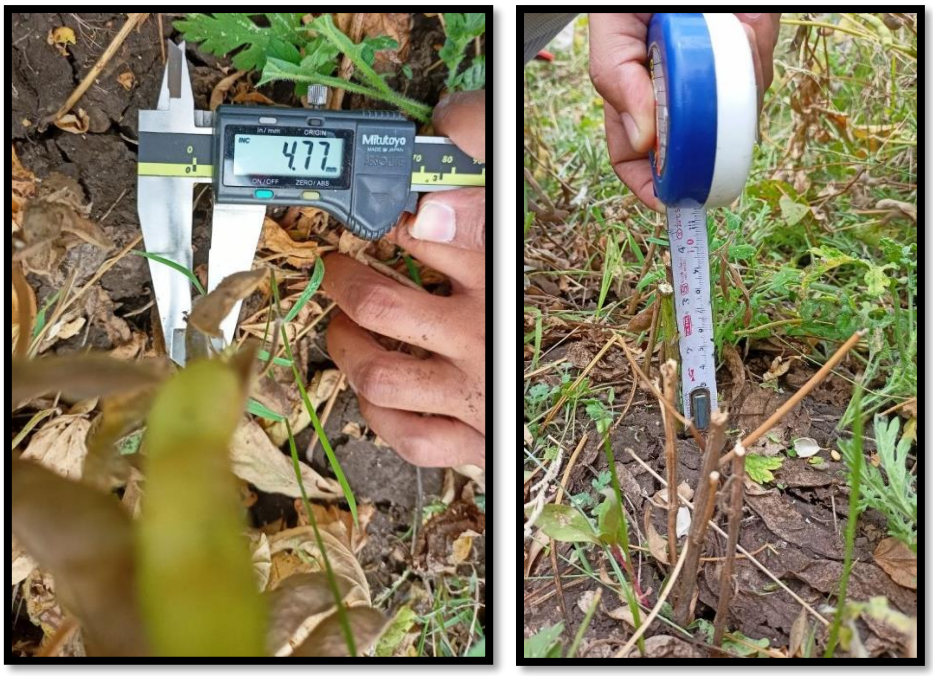

Plate No. 4.1 Measuring stem diameter and height of cut

4.2 Laboratory testing of manual drawn engine operated soybean harvester

The manual drawn engine operated soybean harvester was tested in the workshop of the Department of Farm Power Machinery, Dr. PDKV, Akola for checking functionality of different component of machine.

4.3 Field testing of manual drawn engine operated soybean harvester

Performance evaluation of the manual drawn engine operated soybean harvester was done to test its feasibility for harvesting of soybean crop. Trials were conducted on test plot of total area 0.005 ha.

4.3.1 Field performance of manual drawn engine operated soybean harvester

Field performance of manual drawn engine operated soybean harvester depends upon the measures like total operating time, cutting

width, forward speed, effective field capacity and field efficiency. The harvesting of soybean crop by manual drawn engine operated soybean harvester was carried out on area of 0.005 ha.

4.3.2 Theoretical field capacity

As the average speed of manual drawn engine operated soybean harvester during operation was 1.92 km/h and the total working width of the same was 90 cm. The theoretical field capacity of manual drawn engine operated soybean harvester was found to be 0.172 ha/h. (APPENDIX A).

4.3.4 Effective field capacity

The effective field capacity of mechanical harvesting for test plot. It observed that the average field capacity was as 0.149 ha/h (APPENDIX A).

4.3.5 Field efficiency

The field efficiency of manual drawn engine operated soybean harvester is the ratio of actual field capacity to theoretical field capacity. The field efficiency of mechanical harvesting for test plot are given in table. It observed that the average field efficiency, was 86.6% (APPENDIX A).

4.3.6 Fuel consumption

The average fuel consumption of the manual drawn engine operated soybean harvester to harvest soybean crop was found to be 0.460 l/h.

4.3.7 Cutting efficiency

The cutting efficiency of manual drawn engine operated soybean harvester is calculated by number of plants cut per m^2 to the number of plants per m^2. The average cutting efficiency is 97.83%

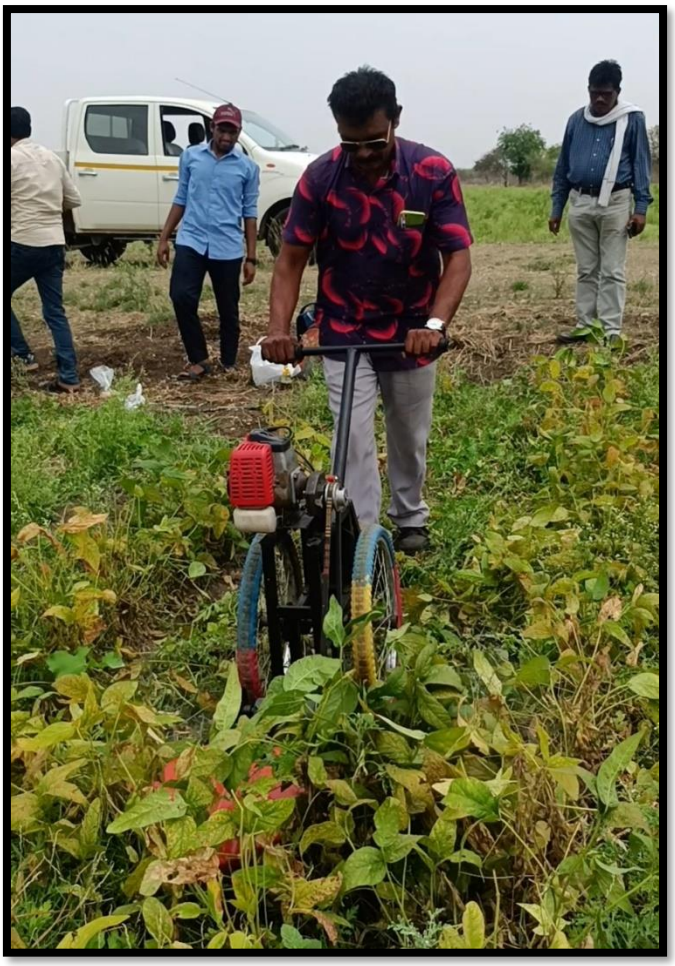

Plate No 4.2: Field testing of manual drawn engine operated soybean harvester

Table 4.3: Cutting efficiency of manual drawn engine operated soybean harvester

Sr. no	Specification	Plot no 1	Plot no 2	Plot no 3	Plot no 4	Avg
1	Plant population	46	40	42	38	41.5
2	No of uncut plant	02	00	01	00	1
3	No of cut plant	44	40	41	38	40.6
4	Cutting efficiency (%)	95.65	100	97.61	100	97.83

Table 4.4: Field performance result of manual drawn engine operated soybean harvester

Sr. No	Parameters	Result
1.	Area covered, ha	0.005
2.	Time required to cover 1 hectare, h	6.7
3.	Effective working width, cm	90
4.	Forward speed, km/h	1.92
5.	Theoretical field capacity, ha/h	0.172
6.	Effective field capacity, ha/h	0.149
7.	Field efficiency, %	86.6
8.	Fuel consumption, l/h	0.460
9.	Cost of operation, Rs/h	158
10.	Cost of operation, Rs/ha	888

Plate No 4.3: Field before testing of manual drawn engine operated soybean harvester

Plate No 4.4 : Field after testing of manual drawn engine operated soybean harvester

4.3.8 Harvesting losses

The measured values of harvesting losses in mechanical harvesting are shown in table 4.5. Delay in harvesting caused grain to shatter due to natural factor (wind, temperature) therefore preharvest losses increase.

4.3.9 Shattering losses

The average values of shattering losses in mechanical harvesting for test plot of field at grain moisture content 9.8% were observed to be 5.88%.

4.3.10 Uncut losses

The average uncut losses in mechanical harvesting in percentage were observed to be 12.83%, as the height of the cut is more than the minimum height of the pods.

4.3.11 Total harvesting losses

Harvesting losses include preharvest. shattering losses and uncut losses The average harvesting losses in mechanical harvesting in percentage were observed to be 18.71%. It is recommended that harvesting losses should be 3% or less.

Table 4.5: Harvesting losses in manual drawn engine operated soybean harvester

Sr. no	Parameters	Test 1	Test 2	Test 3	Test 4	Avg
1	Yield from 1m^2, gm	158.23	128.12	119.32	114.66	130.08
2	Shattering losses, gm	10.02	5.58	8.35	6.67	7.65
3	Uncut losses, gm	18.21	14.20	18.18	16.18	16.69
4	Harvesting losses, g/m^2	28.23	19.78	26.53	22.85	24.34
5	Shattering losses, %	6.33	4.35	6.99	5.81	5.88
6	Uncut losses, %	11.5	11.08	15.23	14.11	12.83
7	Harvesting losses, %	17.83	15.43	22.22	19.92	18.71

4.4 Cost Economics of manual drawn engine operated soybean harvester

The cost of operation per hour and per hectare of manual drawn engine operated soybean harvester for harvesting of soybean crop was computed as per method given in chapter 3.

The cost of manually harvesting was calculated by asserting the raw materials price in the local market. Cost economics of manual drawn engine operated soybean harvester depends upon fixed costs and operating costs. The total cost of operation for harvesting soybean crop with manual drawn engine operated soybean harvester was observed to be

Table 4.6 Cost economics of manual drawn engine operated soybean harvester & manual harvesting

Parameters	Manual drawn engine operated soybean harvester	Manual harvesting
Cost of operation Rs/h	158	540
Cost of operation Rs/ha	888	3000

All the costs calculation are given in Appendix B. The above cost is only for cutting the crop and not for collecting as the manual drawn engine operated soybean harvester is only cut the crop.

CHAPTER V

SUMMARY AND CONCLUSION

Proper harvesting of the crop is one most important operation in crop cultivation practices. The production of soybean is increasing as result of improved methods of farming. But the harvesting techniques are still primitive. Soybean harvesting is carried out manually in most part of our country. Considering the labour shortage during peak harvesting period, risk of damage to the crop due to ultimate rains, short time availability for land preparation and sowing of rabbi season crop it become essential to mechanize the harvesting of soybean crop. Therefore, the performance evaluation of manual drawn engine operated soybean harvester was carried out for harvesting of soybean crop.

Field trials were carried out on total area of 0.005 hectare at the field of Highway Block, Central Research Station, Dr. PDKV, Akola. The performance of manual drawn engine operated soybean harvester was evaluated by forward speed of operation, theoretical field capacity, actual field capacity, field efficiency, shattering losses, uncut losses, harvesting losses, etc.

After conducting the field test of manual drawn engine operated soybean harvester following conclusion are drawn.

1) It harvests the soybean crop minimum uncut losses.
2) It windrowed the cut crop in the adjacent empty space between the crop row which makes it easy for collection.
3) In case of harvest losses, it was found that the uncut losses were more as the height of pod are more close to ground. This was due to found that plant population is more.

4) There is 70% saving in cost of harvesting over manual harvesting method. However to collect the harvested soybean, manual labor is required.

The overall performance of manual drawn engine operated soybean harvester was observed to be satisfactory. It was found that the manual drawn engine operated soybean harvester suitable for intercrop soybean harvesting.

CHAPTER VI

SUGGESTIONS FOR FUTURE WORK

1. Studies should be carried for harvesting of Bengal gram crop as there is need of mechanism in Bengal gram crop harvesting.
2. Need to reduce the overall vibrations so that operator can run the machine comfortably.
3. Need to modify the machine for proper weight distribution, which will further aid in easy pushing of machine in field.

CHAPTER VII

BIBBLOGRAPHY

Alizadeh MR and Allameh A. 2013. Evaluating rice losses in various harvesting practices. International Research Journal of Applied and Basic Sciences, Vol, 4(4): 894-901.

Anonymous (2004): Tractor mounted flail type harvester cum chopper AICRP- FIM. Published by Central Institute of Agril. Engg. Bhopal: 26-27

Bukhari S. A, Q. Mughal, J.M. Baloch, R. J. Malik, and A.N. Mirani (1991) Grain Losses in Wheat Harvested by Tractor Front Mounted Reaper Windrower. Agricultural Mechanization in Asia, Africa and Latin America. 22(3); 15-20.

Devnani R. S. and M. M. Pandey (1985) Design, Development and field Evaluation of Vertical Conveyor Reaper windrower. Agricultural Mechanization in Asia, Africa and Latin America. 16(2): 41-52.

Ebrahimi Nik MA, Khademolhosseini N, Abbaspour- Fard MH, Mahdinia A, and Alami Saied K. 2009. Optimum utilization of low-capacity combines harvesters in high yielding wheat farms using multi criteria decision making. Biosystems Engineering 103: 382-388.

Hafiz Sultan Mahmood, Tanveer Ahmad, Zufiqar Ali and Asif Ali Mirani Performance Evaluation Of Different Fodder Cutter. (ARPN Journal of Engineering Applied Sciences VOL. 11, NO. 24, DECEMBER 2016.

IOSR-JAVS,2013. IOSR Journal of agriculture and veterinary science Vol. 2: 05-08 www.iosrjournals.org.

Junsiri C and Chinsuwan W. 2009. Prediction equations for header losses of combine harvesters when harvesting Thai Hom Mali rice. Songklanakarin Journal of Science and Technology, 31(6):613-620.

Kandel H. and Endres G., 2023 Soybean Production Field Guide. North Dakota State University Extension;137-146.

Philbrook B.D. and E.S. Oplinger (1989) Soybean Field Losses as Influenced by Harvest Delays. Journal of Agronomy. Vol. 81;251-258.

Qamar-uz-Zaman, A.D. Chaudhry, and M. A, Rana (1992) Interrelationship Between Crop and Machine Parameters Responsible for Wheat Harvesting Losses. Pak, J. agri. Sci, 28,227-229.

Rangasamy, K. M. (1993); Evaluation of the power weeder performance, AMA 24 (4): 16-18.

RNAM Test Codes & Procedures for Farm Machinery, 1983. Economic and Social commission for Asia and Pacific, Regional Network for Agricultural Machinery. (Technical Series No. 12), Test Code and Procedure for Harvesting Machines, page no. 207-225.

Singh G. AP. Chaudhury, and D. Gee-Clough. (1988) Performance Evaluation of Mechanical Reapers in Pakistan. Agricultural Mechanization in Asia, Africa and Latin America 19(3), 47-52

Singh L.P., K. K, Jain, V.R. Vagadia., A. H. Memon (2008) Evaluation and Improvement in Design of Self-Propelled Vertical Conveyor Reaper. Agricultural Mechanization in Asia, Africa and Latin America 39(2), 34- 38.

Singh S., D.K. Vasta and M.k. Verma (2007) Feasibility and Performance Evaluation of Power Tiller Operated Reaper in Hills of Himachal Pradesh, agricultural Engineering Today 31(2), 6-10.

SOPA (The Soybean Processors Association of India) Oilseeds-world market and trade as USDA Publication.

Veerangouda M, Sushilendra, Prakask KV and Anantachar M. 2010. Performance Evaluation of Tractor Operated Combine Harvester. Karnataka J. Agric. Sci., 23(2): (282-285).

Vikram singh and Rana Noor Aalam Performance Evaluation of Self-Propelled Fodder Cutter Bar Type Harvesting for Sudan and Berseem Harvesting (International Journal of Science, environment and technology, Vol. 6, No 1, 2017, 935-945).

www.agrifarming.in > home > agriculture farming > soybean farming detailed guide.

Yoshida K. 2003. Analysis of Energy Requirement for Serrated Type Sickle. Trans of ASAE, 7:57-64.

APPENDIX A

Calculation of field capacities and field efficiency of manual drawn engine operated soybean harvester

1) Field capacities of manual drawn engine operated soybean harvester

a) Theoretical field capacity (TFC)

$$\text{Theoretical field capacity(ha/h)} = \frac{S(\frac{km}{hr}) X\ W(m)}{10}$$

Where,

S = Average speed of machine

= 1.92 km/h

W = Theoretical width of machine

= 0.9 m

Therefore,

$$TFC = \frac{S\ X\ W}{10}$$

$$= \frac{1.92X\ 0.9}{10}$$

= 0.172 ha/h

Theoretical field capacity for test plot = 0.172 ha/h

b) Effective or actual field capacity (EFC)

$$\text{Effective field capacity(ha/h)} = \frac{A}{Tp+Tl}$$

Where,

A =Actual area covered during test

T_p= productive time, h (5.7 h)

T_l= non-productive time, h (time lost for turning, cleaning, adjustment of machine) (1 h)

During field test, total time (T_p + T_l) required to covered 1 ha was found to be 6.7 hours.

Therefore, EFC (ha/h) = $\frac{A}{Tp+Tl}$

$= \frac{1}{6.7}$

= 0.149 ha/h

Effective field capacity = 0.149 ha/h

c) Field efficiency

Field efficiency (%) = $\frac{Effective\ field\ capacity\left(\frac{ha}{h}\right)}{Theoretical\ field\ capacity\left(\frac{ha}{h}\right)}$X100

$= \frac{0.149}{0.172}\ X\ 100$

= 86.6 %

Hence, field efficiency of manual drawn engine operated soybean harvester was 86.6%

APPENDIX B

Cost analysis of manual drawn engine operated soybean harvester

A) Fixed cost

Purchase price/make price(C) = 24000

Salvage value (S)(10% of C) = 2400

Annual use (U) = 240

Life span (L) = 8

a) Depreciation = $\frac{P-S}{LXh}$

$=\frac{24000-2400}{8X240}$

= 11.25 /h

b) Interest (10%) = $\frac{P+S}{2}\ X\ \frac{R}{100\ X\ h}$

$=\frac{24000+2400}{2}X\ \frac{10}{100\ X\ 240}$

= 5.5 Rs/h

Fixed cost of manual drawn manual drawn engine operated soybean harvester = a + b

= 11.25 + 5.5

= 16.75 Rs/h

B) Variable cost of manual drawn engine operated soybean harvester

a) Fuel cost =48.76 Rs/h
b) Lubrication oil cost =9.75 Rs/h
c) Wages of operator = 75 Rs/h

d) Repair and maintenance cost = 7 Rs/h

Variable cost = a + b + c + d

= 48.76 + 9.75 +75 + 7

= 140.51 Rs/h

Total cost = Fixed cost + Variable cost

= 16.75 + 140.51

= 157.26 Rs/h

=158 Rs/h (approximately)

Therefore, the cost of operation per hour with manual drawn engine operated soybean harvester was Rs 158

Total cost of operation per hectare,

$$\text{Cost of Operation (Rs/ha)} = \frac{Cost\ of\ harvester(\frac{Rs}{hr})}{Effective\ field\ capacity\ of\ harvester(\frac{ha}{h})}$$

$$= \frac{132.26}{0.149}$$

= 887.65 Rs/ha

=888 Rs/ha (approximately)

Therefore, the cost of operation per hectare with manual drawn engine operated soybean harvester was Rs 888

APPENDIX C

Harvesting losses in manual drawn engine operated soybean harvester

Sr. no	Parameters	Test 1	Test 2	Test 3	Test 4	Avg
1	Yield from 1m^2, gm	158.23	128.12	119.32	114.66	130.08
2	Shattering losses, gm	10.02	5.58	8.35	6.67	7.65
3	Uncut losses, gm	18.21	14.20	18.18	16.18	16.69
4	Harvesting losses, g/m^2	28.23	19.78	26.53	22.85	24.34
5	Shattering losses, %	6.33	4.35	6.99	5.81	5.88
6	Uncut losses, %	11.5	11.08	15.23	14.11	12.83
7	Harvesting losses, %	17.83	15.43	22.22	19.92	18.71

Calculation:

For test plot 1:

Total harvesting losses(gm) = Shattering losses (gm) + Uncut losses (gm)

= 10.02 + 18.21

= 28.23 gm/m^2

Shattering losses (%) = $\frac{\text{Shattering losses (gm)}}{\frac{Yield}{m2}}$ X100

$= \frac{10.02}{158.23}$ X 100

= 6.33 %

Uncut losses (%) = $\frac{Uncut\ in\ gm}{Yield\ /m2}$ X 100

$= \frac{18.21}{158.23}$ X 100

= 11.5 %

Total harvesting losses (%) = Shattering losses (%) + Uncut losses (%)

= 6.33 + 11.5

= 17.83 %

Similarly, calculating for test plot 2, 3 and 4.