Int.J.Curr.Microbiol.App.Sci (2025) *14*(10): 11-20

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 14 Number 10 (2025)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2025.1410.002

Techno-Economic Evaluation of Green Chickpea Pod Stripping cum Shelling Machine

Amrutha Raghavan* and Surendra Jogdand

Department of Farm Machinery and Power Engineering, SVCAET and RS, IGKV, Raipur, (Chhattisgarh), India

**Corresponding author*

Keywords

Green chickpea, Pod stripping, Moisture content, Machine performance, Economics evaluation

Article Info

Received: 15 August 2025
Accepted: 28 September 2025
Available Online: 10 October 2025

ABSTRACT

Green chickpea (*Cicer arietinum* L.) is a nutritional rich pulse crop, but its post-harvest handling, particularly pod stripping and kernel shelling, is still carried out manually, making the process laborious, time-consuming, and un-economical. To address this challenge, a green chickpea pod stripping cum shelling machine was developed at MPUAT, Udaipur, and evaluated at SVCAET&RS, Raipur. The machine is powered by a 1 hp single-phase motor and comprises a stripping unit, shelling unit, blower, and pulley system. Performance evaluation was conducted at five different moisture contents of chickpea. Moisture content of the crop significantly influenced machine performance. At a moisture content of 51.46 per cent, the machine achieved a stripping efficiency of 91.20 per cent, a shelling efficiency of 70.78 per cent, a shelling capacity of 23.96 kg/h. The lowest un-de-pod percentage of 29.23, and the minimum labour requirement of 0.040 man-h/kg. The least kernel damage of 3.16 per cent was observed at a moisture content of 61.35 per cent. Economic analysis showed an operational cost of 199.85 Rs/h or 8.3 Rs/kg assuming the total working hours of 200 per year.

Introduction

Chickpea (*Cicer arietinum* L.), commonly known as Bengal gram or Garbanzo bean, is an important pulse crop of the Fabaceae family. It holds a prominent place in global agriculture due to its nutritional value, particularly its high protein content. India is the largest producer of chickpeas, contributing nearly half of the world's supply, with major production in Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, and Uttar Pradesh) (ANGRAU Bengal gram outlook report 2023-24). Despite its significance, the crop still faces challenges in terms of efficient harvesting and post-harvest handling.

Traditional methods of harvesting, pod stripping, and shelling are largely manual and labor-intensive. Harvesting is usually performed by pulling out the plants, which are then sundried in the field, followed by threshing either manually with sticks or with threshers (Corp *et al.,* 2004). Pod stripping and shelling, especially in the case of green chickpeas, remain difficult tasks when performed manually. These operations are time-consuming, physical demanding, and prone to inefficiencies that lead to loss of quality and yield. The problem is further compounded by the scarcity of labor during peak harvesting seasons, which directly affects profitability for farmers.

Although some advanced methods such as chemical, steam, and large-scale mechanical shelling are available, they are often unsuitable for small and medium-scale farmers. Hence, there is a clear need for appropriate mechanization that can provide an efficient, economical, and farmer-friendly solution. The green chickpea pod stripping cum shelling machine was developed to address these challenges by providing a mechanized solution for efficient pod stripping and shelling. It integrates modern engineering principles to improve throughput, and reduce grain loss.

Materials and Methods

The performance analysis of the green chickpea pod stripping cum shelling machine involved two main operations-stripping and shelling. Pod stripping was carried out using a comb-like mechanism with evenly spaced teeth that detached pods from the plant stalks. The stripped material was then cleaned using vibrating sieves of varying mesh sizes. The collected whole pods were fed into a shelling system equipped with a rubber roller rotating at 243 rpm, which applied gentle pressure and friction to split the pods and release the seeds with minimal damage. Finally, the mixture of kernels, pod fragments, and other residues was separated through sieving to obtain clean chickpea kernels.

The cost economics of the green chickpea pod stripping cum shelling machine involves the analysis of fixed and variable costs associated with its operation. This evaluation assists in figuring out the machine's cost–effectiveness and operational viability under real-world field conditions.

Specifications of MPUAT developed green chickpea pod stripping cum shelling machine

The Green chickpea pod stripping cum shelling machine was developed by the Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan. It consists of a main frame, stripping unit, blower, sieve screen, shelling unit, and pulley.

Dependent parameters: The experiments were planned in randomized block design, having one factor of five treatments and three replications.

Stripping efficiency: Stripping efficiency was calculated as the ratio of the weight of pods stripped after operation to the total weight of pods on the plant before stripping. The stripping efficiency of the machine was evaluated at five different moisture content levels and was determined using the following formula

$$\text{Stripping efficieny} = \left(\frac{\text{weight of pods stripped after operation}}{\text{total weight of pods on plant before stripping}}\right) \times 100 \quad ---(1)$$

Shelling capacity: The shelling capacity was calculated by considering the quantity of shelled pods processed in a given time. The shelling capacity was determined by using the following formula (Feroz *et al.,* 2024).

$$\text{Capacity (kg/h)} = \frac{\text{Weight of pods (kg)}}{\text{Time of operation (h)}} \quad ---(2)$$

Shelling efficiency: Shelling efficiency is a measure of how effectively the machine separates the chickpea kernels from the pods after the shelling processand expressed as (Kumar *et al.,* 2021).

$$\text{Shelling efficiency (\%)} = [1 - \frac{\text{Mass of unshelled pod}}{\text{Total mass of pods}}] \times 100 \quad ---(3)$$

Damage percentage: Damage percentage is defined as the proportion of damaged kernels to the total seeds obtained after shelling, expressed as a percentage (Feroz *et al.,* 2024).

$$\text{Damage (\%)} = \frac{\text{Mass of damged sample}}{\text{Total mass of sample}} \times 100 \quad ---(4)$$

Un-de-pod percentage: The un-de-pod percentage was calculated by dividing the mass of the un-de-pod pods by the total mass of the sample (Kumar *et al.,* 2021).

$$\text{Un} - \text{de} - \text{pod (\%)} = \frac{\text{Mass of un} - \text{de} - \text{pod sample}}{\text{Total mass of sample}} \times 100 \quad ---(5)$$

Labor requirement: Based on the machine's shelling capacity, the number of man-hours needed to shelling one kilogram of peas was determined (Feroz *et al.,* 2024).

$$\text{Labor requirement} \left(\frac{\text{Man} - \text{h}}{\text{kg}}\right) = \frac{1}{\text{Capacity(kg/h)}} \quad ---(6)$$

Results and Discussion

The evaluation of the green chickpea pod stripping cum shelling machine was carried out as per the plan of experiment. Performance of the machine was evaluated at five different moisture contents. The shelling performance was evaluated separately for the first and second passes, and then the data were combined to obtain the overall values. In this case, the total input was considered as the sum of pod weights used in both passes. Each experiment was replicated three times. The dependent parameters were stripping efficiency, shelling capacity, shelling efficiency, damage percentage, un-de-pod percentage, and labor requirement.

Effect of moisture content on stripping efficiency

The stripping efficiency of the machine was evaluated at five different moisture content levels and was determined using Eq. (1). The stripping efficiency of the machine decreased with increasing moisture content. The highest stripping efficiency, 91.20 per cent was recorded at 51.46 per cent moisture content, while the lowest efficiency, 72.60 per cent occurred at 71.84 per cent moisture content. The mean stripping efficiency is 83.62 per cent. The reduction in efficiency at higher moisture levels may be due to increased elasticity and reduced brittleness of the pods, making seed detachment more difficult. Fig. 3 shows the stripping efficiency at different moisture contents.

Effect of moisture content on shelling capacity

The shelling capacity (kg/h) of a chickpea at different moisture content levels, each measured across three replications (R1, R2, R3). The effect of treatment on the shelling capacity was highly significant, indicating strong treatment-induced variability. The results indicate a clear decreasing trend in shelling capacity with increasing moisture content. As the moisture content increased from 51.46 per cent to 71.84 per cent, the shelling capacity showed a corresponding decrease. At the lowest moisture level (51.46%), the maximum shelling capacity recorded was 23.96 kg/h. The lowest shelling capacity was observed at 71.84 per cent moisture content, where the minimum value of 10.84 kg/h was recorded. The data show that shelling capacity decreased with increasing moisture content, indicating that optimal shelling occurs at lower moisture levels. Fig. 4 shows the shelling capacity at different moisture contents.

Effect of moisture content on shelling efficiency

The shelling efficiency was calculated based on the proportions of pods that have been successfully shelled relative to the total mass of pods fed into the machine. The shelling efficiency of the machine was evaluated at five different moisture content levels. The results showed a highly significant effect of moisture content on shelling efficiency, with minimal error variation. The results revealed a significant influence of moisture content on shelling efficiency. At 51.46 per cent moisture content, the mean shelling efficiency was 70.78 per cent. The lowest shelling efficiency was recorded at 61.35 per cent moisture content, with a mean value of 50.98 per cent. However, a substantial improvement in shelling efficiency was observed with further increases in moisture content. At 66.61 per cent and 71.84 per cent moisture levels, the shelling efficiencies increased to 58.26 per cent and 59.40 per cent respectively. This indicates that at lower moisture content, the pods remained brittle, resulting in higher shelling efficiency. As the moisture content increased up to 61.35 per cent, the pods became tougher and more elastic, which reduced the shelling efficiency. However, beyond 61.35 per cent moisture content, the pods softened and passed more easily through the relatively large clearance between the roller and concave sieve, leading to a slight improvement in shelling efficiency, though not reaching the maximum obtained at lower moisture levels. Fig. 5 shows the shelling efficiency at different moisture contents.

Effect of moisture content on damage percentage

The damage percentage was calculated by dividing the weight of the damaged seeds by the total weight of all the seeds collected after shelling. The damage percentage of a chickpea at different moisture content levels, each measured across three replications (R1, R2, R3). The results showed that moisture content had a highly significant effect on damage percentage. The damage percentage varied notably with moisture content. The highest damage was observed at 54.31 per cent, while the lowest damage occurred at 61.35 per cent moisture content. This trend indicates that damage percentage is influenced by the pod’s mechanical response at different moisture levels. At moderate moisture, seeds are sufficiently soft to absorb impact without cracking, leading to lower mechanical damage. Though, the damage percentage again increased with the moisture content higher than 61.35 per cent (w.b.). It can be said that the machine is best suitable to work with the moisture content level of chickpeas at around 60 per cent in view of the lowest damage.Fig. 6 shows the damage percentage at different moisture contents.

Table.1 Specifications of green chickpea pod stripping cum shelling machine

Sl. No.	Particulars description	Specifications
	Main drive	
1.	Diameter of motor pully	180 mm
2.	Diameter of blower pully	90 mm
3.	Diameter of shelling pully	250 mm
	Shelling unit	
1.	Feed hopper shape	Rectangle
2.	Hopper height	230 mm
3.	No of rubber roller	1
4.	Length of each rubber material on roller	350 mm
5.	Thickness of each rubber material	25 mm
6.	Size of sieve, length Width	20 mm 10 mm
7.	Diameter of roller	160 mm
8.	Length of shelling concave sieve	430 mm
9.	Width of shelling concave sieve	380 mm
	Stripping content	
1.	Length of stripping unit	450 mm
2.	No of stripping teeth	37
3.	Distance between 2 stripping teeth	20 mm
4.	Stripping teeth length	25 mm
	Blower	
1.	Diameter of blower casing	360 mm
2.	No of blower blades	6
3.	Size of blower blade, length Width Thickness	390 mm 160 mm 12 mm
4.	Length of blower casing	420 mm
5.	Size of blower opening	110 mm
	Separation section	
1.	No of sieve screen	3
2.	Length of sieve screen	1220 mm
3.	Width of sieve screen	330 mm
4.	Size of pod outlet	102 mm
5.	Size of broken material outlet	82 mm
6.	Size of grain outlet	150 mm
	Over all dimensions of the machine	
1.	Length of machine	1580 mm
2.	Width	510 mm
3.	Height	1305 mm

Table.2 Assessment of technical feasibility of green chickpea pod stripping cum shelling machine

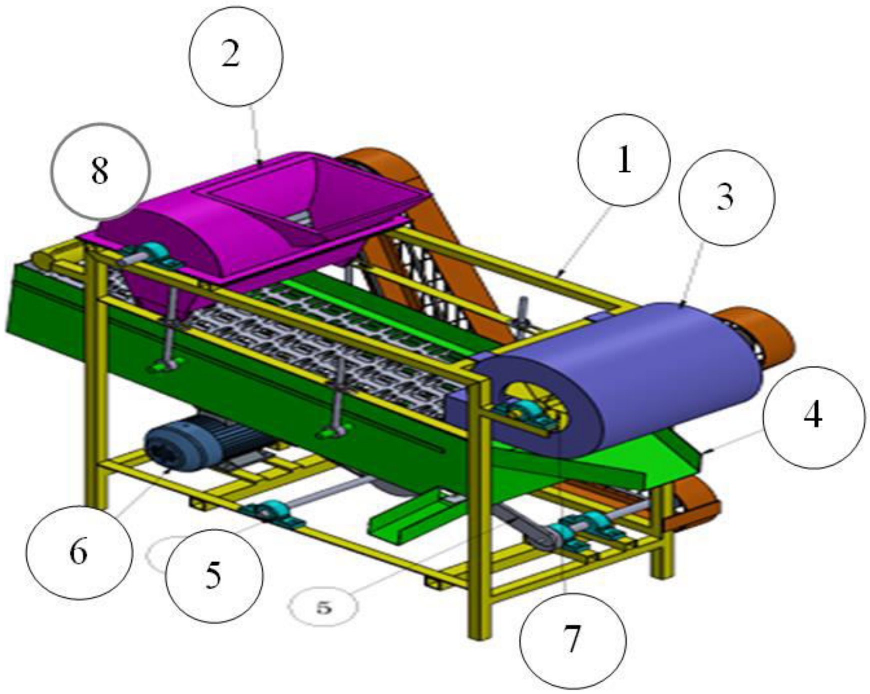
Type of Variable	Variables considered	Unit
Independent variable	Moisture content	%
Dependent variable	Stripping efficiency Shelling capacity Shelling efficiency Damage percentage Un-de-pod percentage Labor requirement	% Kg/h % % % Man-h/kg

Table.3 Effect of moisture content on performance parameters of the machine

Parameters	Moisture content (per cent)				
	51.46	**54.31**	**61.35**	**66.61**	**71.84**
Stripping efficiency	91.20	89.80	85.40	79.10	72.60
Shelling capacity	23.96	23.05	17.07	14.32	10.84
Shelling efficiency	70.78	64.50	50.98	58.26	59.40
Damage percentage	4.71	8.09	3.16	7.2	6.09
Un-de-pod percentage	29.23	35.48	49.24	41.70	40.61
Labor requirement	0.040	0.040	0.050	0.060	0.090

Fig.1 Green chickpea pod stripping cum shelling machine

Fig.2 3-D view of green chickpea pod stripping cum shelling machine



1. Frame
2. Shelling unit
3. Blower
4. Outlet
5. Shaft
6. Motor
7. Blower blade
8. Stripping teeth

Fig.3 Variation of stripping efficiency with moisture content

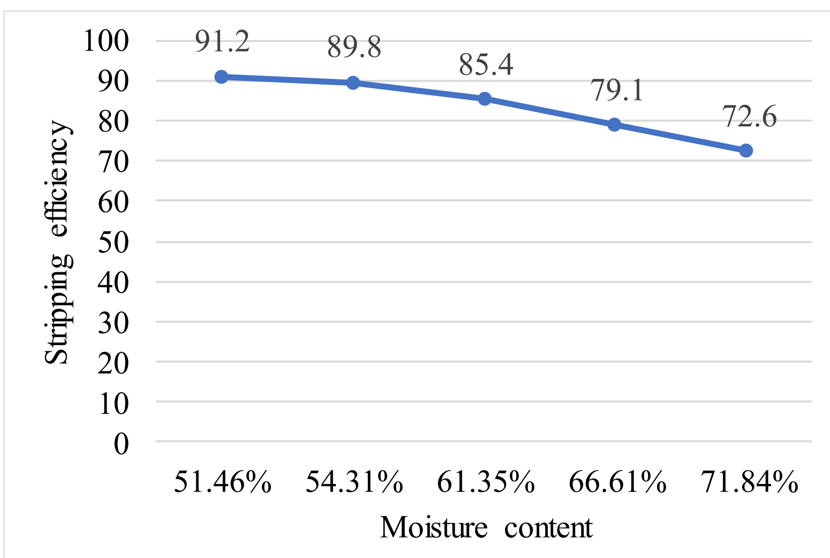


Fig.4 Variation of shelling capacity with moisture content

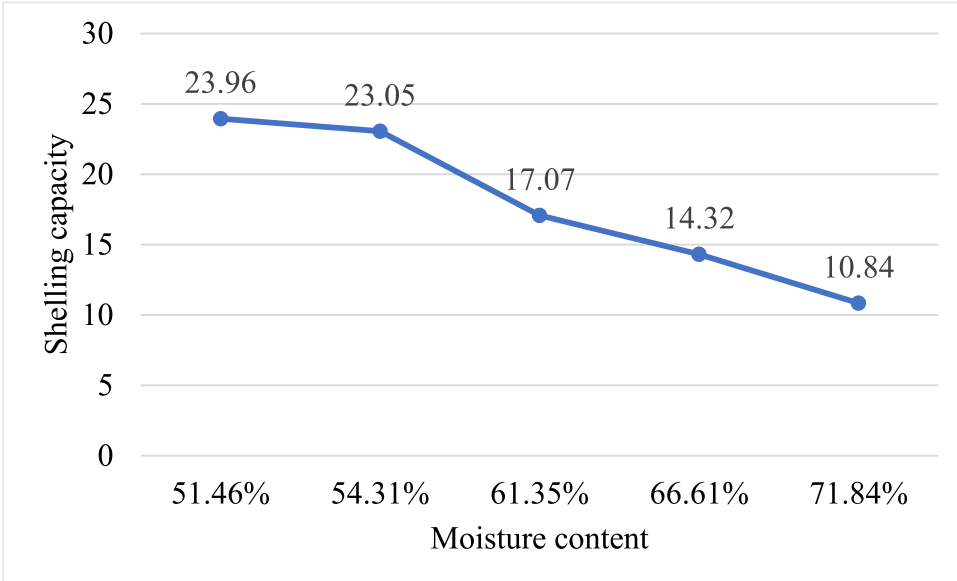


Fig.5 Variation of shelling efficiency with moisture content

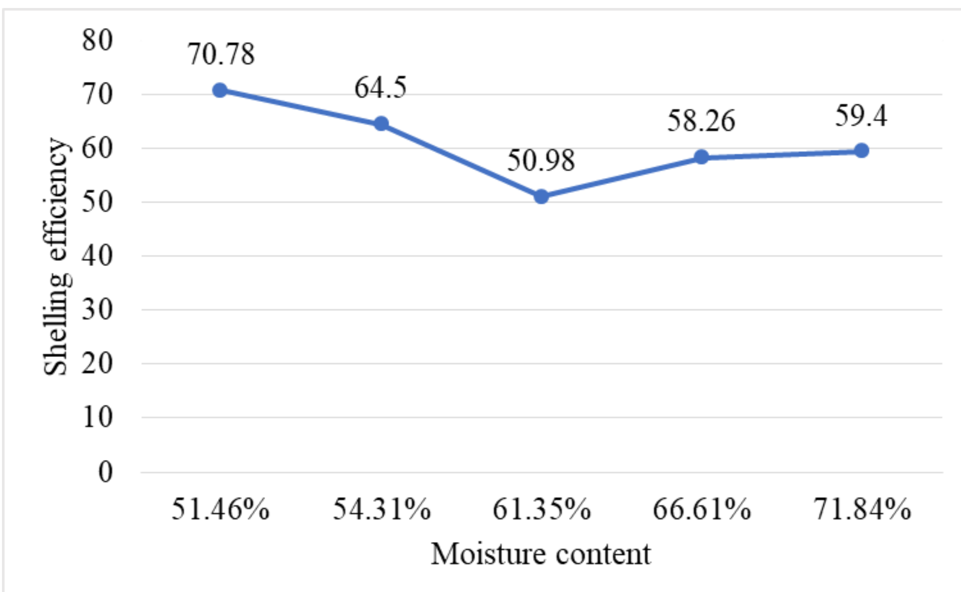


Fig.6 Variation of damage percentage with moisture content

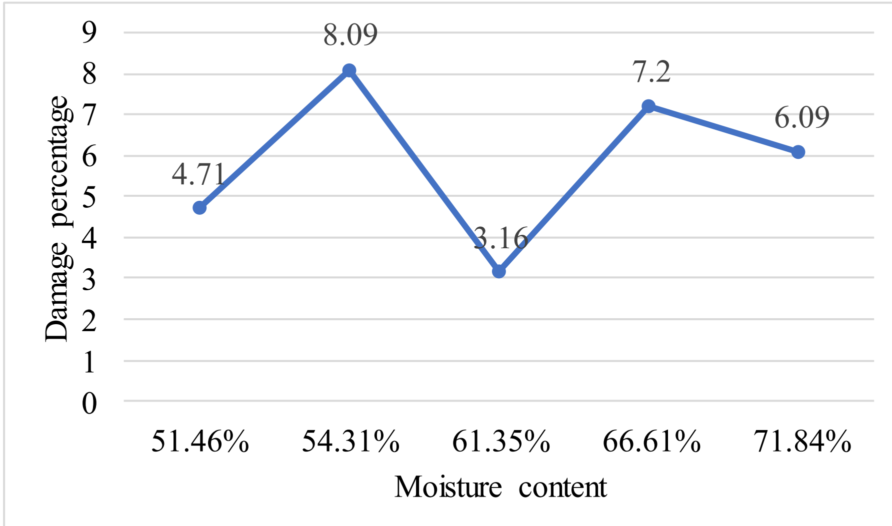


Fig.7 Variation of Un-de-pod percentage with moisture content

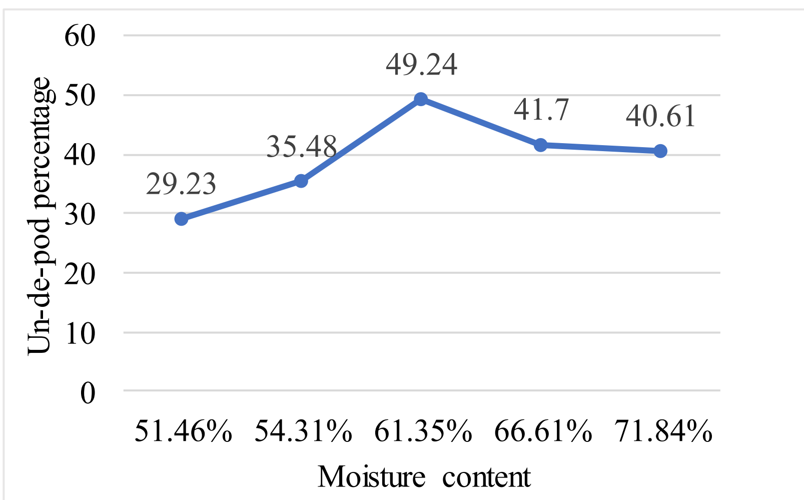
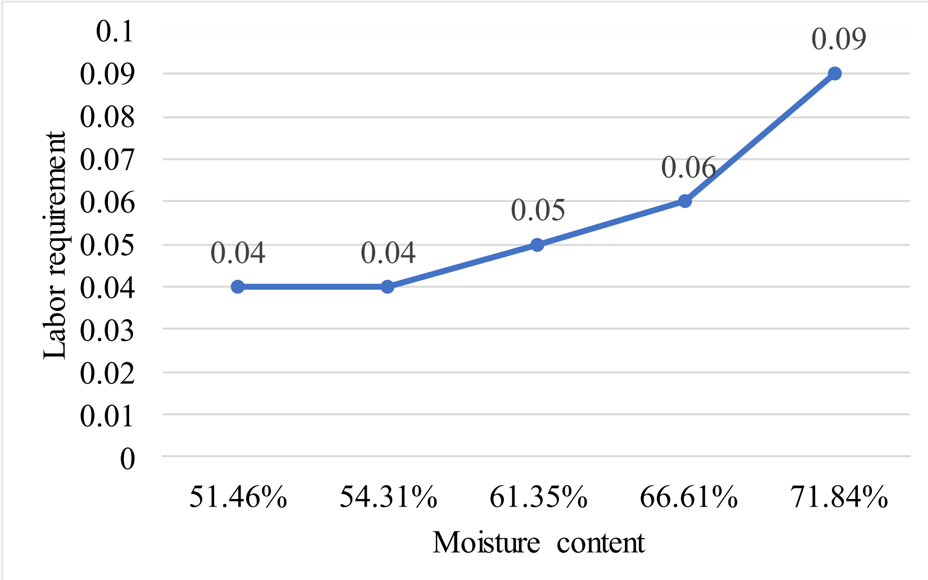


Fig.8 Variation of labor requirement with moisture content



Effect of moisture content on un-de-pod percentage

The un-de-pod percentage of a chickpea at different moisture content levels, each measured across three replications (R1, R2, R3). The results revealed a highly significant effect of moisture content on the un-de-pod percentage. The un-de-pod percentage showed a clear increasing trend with rising moisture content up to 61.35 per cent, where the maximum un-de-pod value of 49.24 per cent was recorded. At lower moisture levels, the un-de-pod percentage was significantly lower, at 29.23 per cent and 35.48 per cent. Beyond 61.35 per cent moisture content, the un-de-pod percentage decreased slightly. This trend suggests that moderate moisture levels make pods too soft and flexible, preventing them from cracking open properly, leading to the highest number of un-de-pod pods. Fig.7 shows the un-de-pod percentage at different moisture contents.

Effect of moisture content on labor requirement

Labor requirement was calculated as the reciprocal of capacity. Labor requirements increased with increasing moisture content. The lowest requirement, 0.04 Man-h/kg, was recorded at 51.46 per cent and 54.31 per cent moisture content, indicating efficient shelling. The highest labor requirement, 0.09 Man-h/kg, was observed at 71.84 per cent moisture content. This reflects that high moisture levels reduce shelling capacity, increasing labor time per kg.

In conclusion, a green chickpea pod stripping cum shelling machine was successfully developed and evaluated. The study showed that moisture content had a significant influence on machine performance. At 51.46 % moisture content, the machine achieved the highest shelling and stripping efficiency, along with maximum capacity, lowest un-de-pod percentage, and reduced labor requirement. The minimum damage was observed at 61.35 %, indicating that the optimal range for efficient shelling lies between these two levels. Total cost of operation per hour was 199 Rs/h and 8.3 Rs/kg assuming the total working hours of 200 per year.

Author Contributions

Amrutha Raghavan: Conceived the original idea and designed the model the computational framework and wrote the manuscript; Surendra Jogdand: Validation, methodology, writing—reviewing

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

References

Ali, K. A. M., Li, S. T., Li, C., Darwish, E. A., Wang, H., Abdelwahab, T. A. M. and Elsaadawi, Y. F. 2024. Optimization and prediction of operational parameters for enhanced efficiency of a Chickpea Peeling machine. Agriculture, 14(5): 780. https://doi.org/10.3390/agriculture14050780

Anonymous.2023. Centre for Agriculture and Rural Development Policy Research. ANGRAU. Bengal gram outlook report. Crop outlook Reports, p.1

Corp, M., Machado, S., Ball, D., Smiley, R., Petrie, S., Siemens, M., Guy, S. 2004. Chickpea Production Guide. Dryland Cropping Systems, Oregon State University, Corvallis, Oregon, United States, 1-14.

Directorate of Pulse Development. 2024. Directorate of Pulse Development report, p.1-10.

Feroz, Z., Zahoor, A. B., Shukla, R. M., Richa, R., Muzamil, M., Faisal, S. and Dixit, J. 2024. Development and performance evaluation of power operated pea depoding machine for small and marginal farmers. SKUAST Journal of Research, 26(2): 174-184. https://doi.org/10.5958/2349-297X.2024.00024.0

Golpira, H. 2015. Redesign and evaluation of a chickpea harvester. Journal of Biosystems Engineering, 40(2): 102-109. https://doi.org/10.5307/JBE.2015.40.2.102

Khekale, S., Lanjewar, S., Bhave, N., Mahankar, P., and Shukla, M. R. 2021. Analysis of the Performance of Green Pea Depoding Machine using Treadle Mechanism. SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology, 13(SUP 2): 296-301.

Kumar, A., Ansari, M. I. and Sabri, I. 2021. Performance evaluation of green pea depoder machine. International journal of chemical studies, 9(1): 844-846.

Kumar, N., Rani, S. and Sharma, A. K. 2023. Performance evaluation and optimization of solar operated plot thresher for chickpea seeds. Current Science, 125(2): 165-171. https://doi.org/10.18520/cs/v125/i2/165-171

Niazi, A., Golpira, H. and Samimi Akhijahani, H. 2022. Evaluation of a Chickpea Harvesting Header with Perforated Plate. Journal of Agricultural Machinery, 12(4): 481-495.

Qabaradin, A. and Tsegaye, A. 2021. An evaluation of soybean thresher for chickpea crop. Irish Interdisciplinary Journal of Science & Research, 5(2): 101-108.

Rajput, M. R., Mandhyan, B. L. and Borkar, P. A. 2013. Testing of modified green chickpea pod stripping cum shelling machine. PKV Research Journal, 37(1 and 2): 120.

Sinha, J. P. 2009. Studies on machine-crop parameters for chickpea seed crop threshing. Agricultural Engineering International: CIGR Journal, 9.

Sonboier, K. K., Mahilang, K. K. S., Immanuel, G. and Minj, P. 2018. Design and development of green pea depoding machine. International Journal of Current Microbiology and Applied Sciences, 7(01): 2319-7706.

How to cite this article:

Amrutha Raghavan and Surendra Jogdand. 2025. Techno-Economic Evaluation of Green Chickpea Pod Stripping cum Shelling Machine. *Int.J.Curr.Microbiol.App.Sci.* 14(10): 11-20. **doi:** https://doi.org/10.20546/ijcmas.2025.1410.002