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# Selection parameters for mechanical harvesting chickpea and its advantages over manual harvesting

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**Abstract**
Chickpea stands out as one of the leading pulse crop extensively cultivated in India followed by Australia, Canada and Turkey. Farmers are increasingly inclined towards transitioning to mechanical harvesting due to its potential to save time, cut in costs that can boost its overall production efficiency. Traditionally, chickpea harvesting in India has been a manual process, primarily because the available chickpea cultivars were not suitable for mechanical harvesting. In contrast, developed nations like the USA, Canada and Australia have successfully implemented mechanical harvesting for chickpea crops by exclusively cultivating varieties compatible with such equipment, ensuring heightened efficiency and cost-effectiveness. Escalating labour costs in India have rendered manual harvesting financially burdensome. Consequently, many farmers are now embracing mechanical harvesting methods, which offer the promise of reduced cultivation and production expenses. The pivotal role of cultivating chickpea varieties well-suited for mechanical harvesting is anticipated to play a crucial role in curbing overall chickpea production costs in India. In summary, the transition from manual to mechanical chickpea harvesting in India is driven by the pursuit of enhancing agricultural efficiency, cutting cultivation costs and to cope up with labour crisis due to high cropping intensity during rabi season. The development and adoption of suitable cultivars for mechanical harvesting have the potential to significantly benefit Indian chickpea farmers by amplifying productivity and minimizing labour-related expenses.

**Keywords:** Mechanical harvesting, plant height, first pod height, semi-spreading growth habit, semi-erect growth habit

## Introduction
Chickpea is a leguminous crop which belongs to the family Fabaceae. It is called by names like Bengal gram, gram or garbanzo. It has been originated from Anatulia, Turkey. It is one of the first grain cultivated crop by man. India is the world's top producer of chickpeas, followed by Pakistan, Turkey, Iran, Mexico, Ethiopia, Canada, Australia, Myanmar, Syria, Bangladesh and Spain, which together account for 97% of the world's production. Increasing cost of labour is a major problem in India because of which cost of chickpea cultivation increases and labour scarcity during the time of harvesting leads to delayed harvesting of pods consequently which leads to seed deterioration and loss of yield. Therefore, mechanical harvesting is preferred by farmers over manual harvesting.

## Mechanical harvesting
To reduce production costs and complete operations on time, any crop must be harvested in an economically feasible way. Machine harvesting is better to manual harvesting since it takes less time and labour to complete. The chickpea is a very significant food legume crop in India and manual harvesting is the main factor in its high production costs. Plant height and first pod height are essential parameters for chickpea machine harvest because lower pod height affects harvest speed and increases the risk of crop loss owing to pods passing under the machine cutter bar.
Mechanization of farm operations will generally reduce the cost of cultivation and is essential for improving the efficiency of Agriculture. The present-day chickpea cultivars are not suitable for mechanical harvesting as the height of the plant is inadequate and the branches of chickpea are close to the ground due to semi-spreading growth habit. The traditional varieties of chickpea have semi-spreading growth habit and the height of lower pods is 15 to 20 cm on an average basis from the ground.

Therefore, these kinds of cultivars are not suitable for mechanical harvesting. Sowing of many crops is done by the use of seed drills and use of combine harvesters in many crops like wheat, rice. This kind of approach will be rapidly increased day by day.

**Fig 1:** First pod height

**Fig 2:** Plant height

**Fig 3:** Clear visual of pod formation

**Fig 4:** Pod formation

**Fig 5:** Maturity stage of chickpea

**Fig 6:** Committee verification at field

**Manual harvesting vs. Mechanical harvesting**

Chickpeas are typically gathered by hand using sickles and then left in the field for a period of 7-10 days to naturally dry under the sun. Following this, a suitable thresher is employed to separate the seeds from the rest of the plant material.

However, this traditional method of harvesting and threshing chickpeas is known for its time-consuming nature and the physical strain it imposes on labourers. The manual process, which involves beating the plants with sticks or subjecting them to trampling by animals or tractor treading, not only demands significant labour, but it also becomes quite monotonous and protracted. Furthermore, these practices can result in undesirable consequences such as seed coat bruising and grain splitting, leading to reduced overall yield**.**

Increasing cost of labour is a major problem in India because of which cost of chickpea cultivation increases and labour scarcity during the time of harvesting leads to delayed harvesting of pods consequently which leads to seed deterioration and loss of yield. Therefore, mechanical harvesting is preferred by farmers over manual harvesting. Nowadays farmers are demanding genotypes that are suitable for mechanical harvesting. The cultivars suitable for mechanical harvesting have the potential to minimize the production cost, enhance resource efficiency and also decrease losses due to harvest. But the present existing cultivars of chickpea are not suitable for mechanical harvesting. For mechanical harvesting, tall plant type with erect growth habit should be accompanied with first pod formation at more than 30 cm above ground are the required desirable traits.

**Fig 7:** Mechanical harvesting

**Fig 8:** Harvesting chickpea using machines

**Table 1:** Differences in expenses between ongoing package of practices and mechanised package of practices

| S. No. | Category | Ongoing package of practices | Mechanised package of practices |
|---|---|---|---|
| 1. | Economics | (In rupees/ha) | (In rupees/ha) |
| 2. | Land preparation | 6600/- | 6600/- |
| 3. | FYM | 10000/- | 10000/- |
| 4. | Fertilizer | 5925/- | 5925/- |
| 5. | Seed | 4000/- | 4000/- |
| 6. | Biofertilizers | 1000 | 1000 |
| 7. | Sowing | 4250/- (15 manpower) | 2500/- (through seed drill) |
| 8. | Intercultural operations | 10625/- (30 manpower) | 3000/- (hiring charges with POL) |
| 9. | Pesticides + labour (6 manpower) | 1500/- | 1500/- |
| 10. | Harvesting/Threshing/Winnowing | 14875/- (35 manpower) | 2500/- (hiring charges included) |
| 11. | Total | 65575/- | 30500/- |
| 12. | Operation time | - | 40% (saving) |
| 13. | Post-harvest losses | 12% | 2% |

On the basis of a study conducted among 27 On-farm trials / FLD conducted in Begusarai, Lakkisarai, Madhubani, Samastipur and Masaurhi districts of Bihar in the year 2021-2022. It was reported that there is saving of nearly half of the input cost in mechanical harvesting of chickpea. The input costs incurred in manual harvesting was around Rs. 65575/- as compared to Rs. 30500/- in mechanical harvesting. The input cost was calculated based on prevailing current local price. We can clearly conclude that the expenses of ongoing package of practices are much higher compared to

mechanised package of practices comprised of sowing, intercultural operations and harvesting. The expenses of ongoing package of practices were more than double to that of mechanised package of practices. Post-harvest losses causes additional 12% loss in case of manual compared to 2% in case of mechanised harvesting.

**Advantages of mechanical harvesting**

- Enhanced benefit-cost ratio adds to farmers income in the form of cost cutting and net saving.
- Greater efficiency and less reliance on labour. Saving of nearly 40 percent in terms of time and labour.
- Relatively very less operational time and efforts are needed.
- Chickpea harvesting by machine will save production costs and minimize the chance of crop damage by wind, rain, and other factors that could arise during the extra time needed for manual harvesting. Farmers will find this more appealing and rewarding.
- Timely harvesting can help minimize losses caused by pod borers and larvae.
- Due to erect to semi-erect growth habit in chickpea plants suitable for mechanical harvesting receives uniform fungicide and pesticidal spray above and below the canopy.
- Due to proper incidence of light all over the plant gets almost no place to hide for the pathogens and pests. Thus, it is advantageous over the spreading type in having less utilization of fungicide and pesticide.
- Post-harvest losses are not more than 2 percent in mechanical harvesting chickpea.
- Growing mechanical harvesting chickpea doesn't mean that harvesting will be done only through machine. But it makes manual harvesting easier and labour friendly.

**Disadvantages of mechanical harvesting**

- High input costs.
- Engagement of labourers and time is very high which is a great challenge to chickpea cultivation.
- Reduced effectiveness of fungicidal and pesticidal spray in spreading type of chickpea.
- The crop could suffer certain damage from mechanical harvesters, particularly if the machinery is not correctly adjusted or operated. But mechanical harvesting chickpea does not only mean that harvesting is done by machine.
- Spreading type growth habit may also result in more ground cover, making it more difficult even for manual harvesting due to difficulty in uprooting. This can be physically demanding and may contribute to discomfort or fatigue among workers.
- In manual harvesting post-harvest losses is upto 12 percent in bringing crop from field to store.

**Criteria essential for mechanical harvesting in chickpea**

In the realm of chickpea cultivation, the traits of upright growth and the initial pod height above the ground (ground clearance) play pivotal roles in determining the choice of cultivar for mechanized harvesting (Chaturvedi *et al*., 2014) [8]. Predominantly, Indian chickpea varieties exhibit a semi-spreading growth habit with minimal ground clearance, rendering them unsuitable for mechanical harvesting. Notably, the loss incurred during machine harvest is notably higher for semi-erect genotypes (approximately 20%) compared to their taller and more erect counterparts, which experience lower losses ranging from 2.6% to 5.0% (Haddad *et al*., 1988) [9]. Presently, the widespread adoption of mechanical harvesting is evident in the case of rice and wheat in India. Similarly, there is a substantial demand among farmers for chickpea cultivars that can be efficiently harvested using combine harvesters (Daheriya, 2014) [10]. However, only a limited number of Indian chickpea cultivars are currently deemed suitable for mechanical harvesting (Chaturvedi *et al*., 2014) [8]. Consequently, there is a concerted effort underway to develop chickpea cultivars specifically tailored for efficient mechanical harvesting.

The two main essential parameters for mechanical harvesting in chickpea are

- Plant height
- First pod height

Plant height was measured as the total length of plants and varied significantly with environment and variety. Height of first pod character is also varied with environment and variety.

Chickpea genotypes with tall and semi-erect type growth habit can be able to accommodate a greater number of plants per unit area and can also give a high yield comparing to the existing cultivars. One more beneficial aspect of such plant types is that there is a reduced build-up of humidity in crop canopy due to incidence of more solar radiation which will reduce or minimize the damage due to foliar diseases. Suitable agronomic practices will also be worked out for the breeding lines suitable for mechanical harvesting. Elite breeding lines suited to mechanized harvesting and adapted to the target regions will be developed through target breeding for strengthening breeding programs for further cultivar development.

Development of chickpea cultivars with upright and tall growth habit having the fruiting zone starting at about 30cm from the ground level are suitable for combine harvesting. Cultivars with 30-40% more height than the existing cultivars and having a semi-erect to erect type of growth habit will make the cultivars of chickpea suitable for mechanical harvesting. These types of cultivars can be developed through intensive breeding programmes. This is particularly essential for the northern part of India where the chickpea area has declined over 3 million ha due to replacement of chickpea with wheat and other high value crops.

**Chronological advancement of chickpea improvement suitable for mechanical harvesting**

**First machine harvestable chickpea variety**

The introduction of the chickpea variety, NBeG 47, marks a significant milestone in Andhra Pradesh's agricultural landscape. It was developed by Dr. Veera Jayalakshmi. This particular chickpea cultivar is notable for being the first machine-harvestable variety released in the state. The variety grows to a height of 60 cm under typical conditions in southern India, was developed by crossing an ICRISAT line (ICCV 2) with a local line (PDG 84-16). It is suitable for mechanical harvesting, just like paddy or wheat. Its suitability for the variable climate conditions of Andhra Pradesh holds promise for local farmers. A recent demonstration of this development took place in a farmer's field located in the Anantapur district of Andhra Pradesh. The demonstration showcased the practical benefits of this machine-harvestable variety. Farmers were able to witness firsthand how adopting

this cultivar can result in substantial time and cost savings in the cultivation and harvesting processes. This innovative chickpea variety represents a step forward in agricultural practices in Andhra Pradesh, offering local farmers an opportunity to improve their efficiency and productivity while adapting to the region's diverse climatic conditions.

GL12021, GL13016, ICCV13604, ICEL3 and ICCV11605 were identified as promising genotypes that are suitable for mechanical harvesting in the study at PAU, Ludhiana and ICRISAT, Hyderabad.

Chickpea varieties i.e., GBM 2, Dheera, Phule G08108 and BRC1 could be suitable for mechanical harvesting due to their plant stature, height of the lowest pod bearing branches and seed yield were identified as promising genotypes suitable for mechanical harvesting in an experiment conducted at regional research farm, Nandyal, Andhra Pradesh.

The chickpea varieties GBM2, Dheera, and BRC1 have better morphology, making them ideal for mechanical harvesting and increased seed yield.

The plant height and primary branch angle of ICCV 181607 were similar to those of the machine-harvestable genotype NBeG 47, and the height of the first pod was likewise significantly higher than that of NBeG 47. It was identified as promising genotype suitable for mechanical harvesting at regional research station, Nandyal, Andhra Pradesh.

HC 5, also known as Haryana Chana 5, is characterized by its tall, upright growth, low biomass and moderate tolerance to lodging. These features make it particularly well-suited for mechanical harvesting. Traditional bushy or semi-spreading chickpea cultivars are unlike HC 5, which has a distinctive morphology and is ideal for machine harvesting.

## Conclusion

Considering the above-mentioned facts, it was found that mechanical harvesting of chickpea will reduce the cost of cultivation and production cost and also reduce the chances of damage to the crop due to several factors like rain, winds and other biotic as well as abiotic factors which may occur during the manual harvesting period. The release of cultivars with these characters will benefit the farmers in reducing the cost of cultivation and also help in increasing the net profit from cultivation of chickpea. This will be more attractive and also remunerating to the farmers. So, from the above article it can also be concluded that the plant height of the existing cultivars should be increased by 30-40% having semi-erect to erect type of growth habit and the height of first pod should have a ground clearance of atleast 25 cm or above to make the cultivar suitable for mechanical harvesting. Thus, the selection parameters of such crop improvement programmes must include plant height, erectness, nonlodging characteristics and ground clearance of the first pod. The study suggested the significant reduction in expenditure occurred in mechanised package of practices. So, the mechanical harvesting is much beneficial and farmer friendly.

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